Manitoba Ambient Air Quality Annual Report for 1997, 1998 and 1999

By B.P. Krawchuk
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Annual Reports for 1997, 1998 and 1999

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Conservation

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Includes at least 10% post-consumer waste

Krawchuk, B.P., 2002 Manitoba Ambient Air Quality Annual Reports for 1997, 1998 and 1999, Manitoba Conservation, Air Quality Section, Report No. 2002-08, xvi+ 100

ABSTRACT

As part of an on-going environmental quality monitoring program, Manitoba Conservation monitored the quality of ambient air at several urban locations during 1997, 1998 and 1999. This monitoring consisted of the use of established monitoring sites having dedicated instrumentation primarily for continuous air sampling and analysis. This report covers data from the above activities of Manitoba Conservation and selected other ambient monitoring performed by companies under Manitoba Environment Act requirements.

The ambient air quality program is structured to determine air quality in two areas: general urban air quality and air quality in the vicinity of some selected industries.

The general urban air quality program consisted primarily of sampling activities within the Federal/Provincial National Air Pollution Surveillance (NAPS) program. Sampling at NAPS sites consisted of measurement of the air pollutants: carbon monoxide, nitrogen dioxide, nitric oxide, nitrogen oxides, ground level ozone, total suspended particulate matter, inhalable particulate, soiling index (coefficient of haze), volatile organic compounds, polyaromatic hydrocarbons, aldehydes and ketones, lead, sulphates and nitrates. Of these contaminants, total suspended particulate matter most often exceeded the 24-hour provincial standard. Based on the Canadian Annual Index of Air Quality, the air quality at the downtown and residential stations in Winnipeg was rated "Good" (the best rating) most of the time (>90%).

The monitoring of air quality in the vicinity of specific industries having (or potentially having) atmospheric emissions was restricted to the areas around the Northern smelters (at Flin Flon and Thompson) and an industrial park in Brandon. Monitoring was specifically for the pollutant(s) of industrial emission. Data from Flin Flon showed a continuing presence within the community of elevated sulphur dioxide levels with excursions above air quality objectives. Some ammonia levels above air quality objectives were observed in the Brandon industrial park area.

Krawchuk, B.P., 2002. *Rapport sur la qualité de l'air ambiant au Manitoba pour 1997, 1998 et 1999.* Ministère de la Conservation du Manitoba, Section de la qualité de l'air. Rapport n° 2002-08, xvi + 100

RÉSUMÉ

Dans le cadre d'un programme permanent de surveillance de la qualité de l'environnement, le ministère de la Conservation du Manitoba a suivi de près la qualité de l'air ambiant dans plusieurs secteurs urbains durant les années 1997, 1998 et 1999. Ce suivi a été effectué par l'intermédiaire de prélèvements d'air en continu à des fins d'analyse dans plusieurs stations de surveillance pourvues d'instruments de mesure entièrement destinés à cette tâche. Ce rapport fait le bilan des données recueillies dans le cadre du programme mené par le ministère de la Conservation du Manitoba et incorpore également des résultats du même genre recueillis par des entreprises privées, en vertu de la *Loi sur l'environnement*.

Le programme de surveillance de la qualité de l'air a deux grands axes : déterminer la qualité globale de l'air en région urbaine ainsi que celle observée à proximité de certaines industries bien particulières.

Le programme de surveillance de la qualité générale de l'air en région urbaine relève du Réseau national de surveillance de la pollution atmosphérique (RNSPA) mis en œuvre par les gouvernements fédéral et provincial. Il consistait principalement à prélever des échantillons d'air pour y mesurer les quantités de polluants suivants : le monoxyde de carbone, le dioxyde d'azote, le monoxyde d'azote, les autres oxydes d'azote, l'ozone au niveau du sol, les hydrocarbures aromatiques polycycliques, les composés organiques volatils, l'aldéhyde et la cétone, le plomb, les sulfates et les nitrates. Il a permis également d'évaluer l'indice de souillure (coefficient de transmission), la quantité totale de particules en suspension dans l'air et la quantité de particules pouvant être inhalées. Les échantillons prélevés ont révélé que la quantité totale de particules en suspension excédait le plus souvent la norme provinciale établie pour une exposition de 24 heures. Selon l'indice annuel canadien, la qualité de l'air aux stations du centre-ville et à celles des secteurs résidentiels de Winnipeg a été qualifiée de « bonne » (meilleure cote de l'indice) dans la grande majorité des cas (+ de 90 %).

La qualité de l'air à proximité d'industries qui émettent ou pourraient émettre des déchets atmosphériques n'a été évaluée que dans les régions proches des fonderies du Nord (à Flin Flon et à Thompson) ainsi qu'à proximité d'un parc industriel de Brandon. Les analyses étaient plus particulièrement orientées vers la détection des émissions industrielles. Les relevés faits à Flin Flon ont montré une présence continue et élevée d'anhydride sulfureux dans l'air ambiant de cette communauté, qui dépassait fréquemment le seuil fixé par la province. Certains taux trop élevés d'ammoniac ont également été enregistrés dans la région du parc industriel de Brandon.

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As	Arsenic
Cd	Cadmium
CO	Carbon Monoxide
COH	Coefficient of Haze
Cu	Copper
D.L.	Detection Limit
IQUA	Index of the Quality of Air
MAL	Maximum Acceptable Level
MDL	Maximum Desirable Level
MTL	Maximum Tolerable Level
N/A	Not Available
NAPS	National Air Pollution Surveillance (air quality monitoring network)
N.D.	Not Detected
NH_3	Ammonia
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NO_3^-	Nitrates
O_3	Ozone (ground level)
PAH	Poly-Aromatic Hydrocarbons
Pb	Lead
PCDD/PCDF	PolyChlorinated Dibenzo-*p*-Dioxins/PolyChlorinated Dibenzo-*p*-Furans
$PM_{2.5}$	Inhalable Particulate (particulate matter less than 2.5 µm in diameter)
PM_{10}	Inhalable Particulate (particulate matter less than 10 µm in diameter)
$24PM_{2.5}$	Inhalable particulate measured continuously over a 24 hour period
$24PM_{10}$	Inhalable particulate measured continuously over a 24 hour period
pg/m^3	Picograms (10^{-12} g) per cubic metre
pphm	parts per hundred million (by volume)
ppm	parts per million (by volume)
SO_2	Sulphur Dioxide
$SO_4^=$	Sulphates
TSP	Total Suspended Particulate matter
$\mu g/m^3$	micrograms (10^{-6} g) per cubic metre
µm	micrometre ($1x10^{-6}$ metre)
VOC	Volatile Organic Compounds
Zn	Zinc
>	greater than
<	less than

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INTRODUCTION

The Province of Manitoba has monitored ambient air at several locations throughout Manitoba since 1968. During 1997, 1998 and 1999, monitoring activities by Manitoba Conservation and companies, under Environment Act requirements, took place in Winnipeg, Brandon, Thompson, and Flin Flon. This report presents data and a discussion of the data generated by the above monitoring activities during 1997, 1998 and 1999 (January 1 through December 31, respectively). During 1998 and 1999, special monitoring activities were undertaken in the Tilston, Manitoba area as a result of concerns regarding the activities of the petroleum industry in the area (Manitoba Conservation, 2000).

The majority of sampling is of a continuous nature involving dedicated monitors in permanent stations and can be divided into two basic categories: (1) General or Urban Air Quality monitoring; and (2) Source specific or Industrial monitoring. Much of the General or Urban Air Quality monitoring is performed under the auspices of the Federal-Provincial National Air Pollution Surveillance (NAPS) program, which provides a nationwide data base for determining air quality levels across Canada, and also documents trends arising as a result of changing industrial activity, fuel use, population density and use of pollution control strategies.

Source specific or Industrial monitoring is performed by the Impingement Program within the Air Quality Section as well as by the regulated companies. This monitoring contributes to the evaluation of ambient air quality in the vicinity of specific industries in order to determine compliance with Provincial Air Quality Guidelines and Objectives.

This report covers the 1997, 1998 and 1999 data for the following parameters: Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Nitric Oxide (NO), Nitrogen Oxides (NO_x), Ground Level Ozone (O_3), Ammonia (NH_3), Sulphur Dioxide (SO_2), Soiling Index (COH), Total Suspended Particulate (TSP), Inhalable Particulate (PM_{10}), Inhalable Particulate ($PM_{2.5}$), Lead (Pb), Sulphates (SO_4^-), Nitrates (NO_3^-), Arsenic (As), Cadmium (Cd), Copper (Cu), Zinc (Zn), Volatile Organic Compounds (VOCs),

PolyAromatic Hydrocarbons (PAHs), Polychlorinated Dibenzo-*p*-Dioxins/Furans (PCDDs/PCDFs) and Aldehydes and Ketones.

The purpose of this report is: 1) to outline ambient air monitoring activities in the Province during 1997, 1998 and 1999; 2) to provide summary statistics and a comparison to air quality objectives and/or guidelines (where applicable); 3) to compare 1997, 1998 and 1999 data with previous years; and 4) to provide a rating of the air quality relative to the Canadian Annual Index of Air Quality for major monitoring sites.

BACKGROUND

A) Manitoba Air Quality Objectives and Guidelines

The Province of Manitoba has adopted the National Ambient Air Quality objectives for those pollutants for which such objectives have been promulgated (sulphur dioxide, suspended particulate matter, carbon monoxide, ozone, and nitrogen dioxide). Air Quality Guidelines have been developed and adopted by the Province for other specific pollutants (Manitoba Conservation 1999).

The guidelines have three levels: the maximum tolerable level (MTL), the maximum acceptable level (MAL) and the maximum desirable level (MDL) which are defined in Table 1.

In the majority of cases, urban air quality is expected to meet the MAL, whereas, in rural areas, it is the long term goal to ensure that the MDL's are not exceeded.

A list of "Ambient Air Criteria" currently endorsed by Manitoba Conservation is presented in Table 1.

TABLE 1: OBJECTIVES AND GUIDELINES FOR VARIOUS AIR POLLUTANTS AMBIENT AIR CRITERIA

The following schedule lists maximum time-based pollutant concentration levels for the protection and preservation of ambient air quality within the Province of Manitoba. Each contaminant is classified either as having objective or guideline status depending upon several factors. The objective

classification is directed toward those air pollutants sufficiently widespread in presence and of potential environmental effect that formulation of limits has been thorough and well documented. The guideline classification is used for those pollutants of a more localized presence and for which a lesser degree of documentation in support of the chosen criteria is available.

For the air contaminants mentioned in Column 1, the amount thereof in the outside air measured in the units set out in Column 2 during the period of time set out in Column 3, shall not be in greater concentration than the amount shown in:

- Column 4 representing the MAXIMUM TOLERABLE LEVEL which denotes a time - based concentration of air contaminant beyond which, due to a diminishing margin of safety, appropriate action is required to protect the health of the general population.

- Column 5 representing the MAXIMUM ACCEPTABLE LEVEL which is deemed essential to provide adequate protection for soils, water, vegetation, materials, animals, visibility, personal comfort and well-being.

- Column 6 representing the MAXIMUM DESIRABLE LEVEL which defines the long term goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of Manitoba and for the continuing development of control technology.

This schedule is intended to serve as a guide for the evaluation of air quality and for planning purposes. The selection of the appropriate concentration category will depend upon the degree of protection to be afforded to affected receptors. Maximum Tolerable Levels are only for evaluation purposes to identify the severity of an anthropogenic or natural phenomenon in order to protect human health and institute appropriate corrective action. In general, Maximum Acceptable Levels are not to be exceeded in any urban centre including areas that are in the vicinity of industries with atmospheric emissions. Within rural areas, it is the goal to maintain pollutant concentrations at or below Maximum Desirable Levels.

Column 1		Column 2	Column 3	Column 4	Column 5	Column 6
Name of Contaminant	Contaminant Classification	Units of Concentration Measurement	Period of Time Contaminant is Measured	Maximum Tolerable Level Concentration	Maximum Acceptable Level Concentration	Maximum Desirable Level Concentration
Ammonia CAS: 7664-41-7	Guideline	milligrams per cubic metre (parts per million) of air	1-hour average		1.4 (2.0)	
Carbon Monoxide CAS: 630-08-0	Objective	milligrams per cubic metre (parts per million) of air	1-hour average 8-hour average	20 (17)	35 (30) 15 (13)	15 (13) 6 (5)
Chromic Acid (as Cr^{+6})	Guideline	micrograms per cubic metre of air	1-hour average		4.5	
Flourides (as HF) CAS: 7664-39-3	Guideline	micrograms per cubic metre (parts per billion) of air	24-hour average 7-day average 30-day average 70-day average		0.85 (1.06) 0.55 (0.69) 0.35 (0.44) 0.20 (0.25)	0.40 (0.50) 0.22 (0.28)
Formaldehyde CAS: 50-00-0	Interim Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average		60 (49)	
Hydrogen Chloride CAS: 7647-01-0	Guideline	micrograms per cubic metre (parts per million) of air	1-hour average		100 (0.07)	
Hydrogen Cyanide CAS: 74-90-8	Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average 1-year average		40 (36) 3 (2.7)	
Hydrogen Sulphide CAS: 7783-06-04	Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average 24-hour average	1400 (1000)	15 (11.0) 5 (4.0)	1 (0.7)
Lead CAS: 7439-92-4	Guideline	micrograms per cubic metre of air	24-hour average		5.0	
Methylene Diphenyl Diisocyanate (MDI) CAS: 101-68-8	Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average 1-year average		3 (0.3) 0.5 (0.05)	
Nitrogen Dioxide CAS: 10102-44-0	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hour average annual arithmetic mean	1000 (0.53)	400 (0.213) 200 (0.106) 100 (0.053)	 60 (0.032)
Odours	Guideline	odour units	two tests not less than 15 minutes apart nor more than 60 minutes apart		Residential Zone 2.0 (see note 2) Industrial Zone 7.0 (see note 3)	<1.0 (less than the odour threshold)

Column 1		Column 2	Column 3	Column 4	Column 5	Column 6
Name of Contaminant	Contaminant Classification	Units of Concentration Measurement	Period of Time Contaminant is Measured	Maximum Tolerable Level Concentration	Maximum Acceptable Level Concentration	Maximum Desirable Level Concentration
Ground-Level Ozone CAS: 10028-15-6	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hour average annual arithmetic mean	400 (0.20)	160 (0.082) 50 (0.025) 30 (0.015)	100 (0.05) 30 (0.015)
Phenol CAS: 108-95-2	Guideline	micrograms per cubic metre (parts per billion) of air	1-hour average		63 (16)	
Soiling Index	Guideline	coefficient of haze per 1000 feet of air	24-hour average annual arithmetic mean		1.0 0.45	0.45 0.30
Styrene CAS:100-42-5	Guideline	micrograms per cubic metre (parts per billion) of air	24-hour average		400 (94)	
Sulphur Dioxide CAS: 7446-09-5	Objective	micrograms per cubic metre (parts per million) of air	1-hour average 24-hour average annual arithmetic mean	800 (0.31)	900 (0.34) 300 (0.11) 60 (0.02)	450 (0.17) 150 (0.06) 30 (0.01)
Sulphuric Acid Mist CAS: 7664-93-9	Guideline	micrograms per cubic metre (parts per million) of air	1-hour average		100 (0.025)	
Suspended Particulate Matter	Objective	micrograms per cubic metre of air	24-hour average annual geometric mean	400	120 70	60

Note 1: Nuisance odours from environmentally-regulated developments are managed using a strategy based on the prevention/minimization of odour releases and the use of community based standard to determine the acceptability of the ambient odour in the community. It is intended that the odour unit limits be used only for evaluating potential impacts on a community during the environmental impact assessment of new or modified developments.

Note 2: One volume of odourous air diluted with one volume of odour free air

Note 3: One volume of odourous air diluted with six volumes of odour free air

All measurements of air quality are corrected to a reference temperature of 25°C and to a reference pressure of 101.3 kilopascals.

B) POLLUTANTS

Characterization of the air pollutants mentioned in this report is as follows:

Carbon Monoxide (CO) is a colourless, odourless and tasteless gas slightly lighter than air. It is considered a dangerous asphyxiant because it combines strongly with the hemoglobin of the blood and reduces the blood's ability to carry oxygen to cell tissues. CO is a product of incomplete combustion of carbon and is emitted by fossil fuel combustion sources (i.e. motor vehicles). CO is measured on a continuous basis by the technique of non-dispersive infrared spectrometry and the data is generally reported in the unit form of hourly averages from which further time-weighting can be determined.

Nitrogen Dioxide (NO_2) is a reddish-brown gas with a pungent, irritating odour. It originates chiefly from combustion sources as well as from conversion of nitric oxide. Nitrogen dioxide exerts its primary toxic effect on the lungs and can be associated with increased susceptibility to respiratory infections and abnormal dilation of the air spaces and distension of the lung's walls. Nitrogen dioxide also suppresses vegetation growth, causes corrosion of metals, reduces visibility, and acts as a precursor in the formation of ground level ozone by reacting with hydrocarbons. It is measured continuously by the technique of chemiluminescence with unit data reported as hourly averages.

Nitrogen dioxide is also recognized as a significant contributor to the formation of acid rain.

Nitric Oxide (NO) is a colourless, odourless and tasteless gas which in nature is produced by biological action but in polluted atmospheres is produced primarily by fuel combustion in both stationary and mobile sources. By itself nitric oxide is not usually considered a pollutant but in a polluted atmosphere, it is readily oxidized to nitrogen dioxide through photochemical secondary reaction. Nitric oxide is measured concurrently with nitrogen dioxide by the technique of chemiluminescence and the data are processed as hourly averages.

Ozone (O_3) is a pungent irritating gas formed at high altitudes by photochemical reaction involving molecular and atomic oxygen. Ozone and other oxidants are formed in polluted atmosphere at ground level as a result of a rather wide variety of photochemical reactions involving nitrogen oxides and

reactive hydrocarbons. In the stratosphere it acts as a beneficial shield to screen unwanted ultraviolet radiation, whereas at ground level it is a pollutant. The overall effect of ozone is a stinging of the eyes and the mucous membranes. It is also responsible for an increase in asthma effects and respiratory restriction. Ozone reduces crop yields, injures vegetation and weakens materials such as rubber and certain fabrics, and is the major contributor to the formation of smog. Ground level ozone is measured by use of UV photometry and unit data are reported as hourly averages.

Ammonia (NH_3) is a colourless gaseous alkaline compound of nitrogen and hydrogen. It is lighter than air, of extremely pungent smell and taste, very soluble in water, and can be easily condensed by cold and pressure to a liquid. Ammonia is an important industrial and agricultural compound used both free and combined. Typical uses are as a fertilizer and as an explosive. Ammonia is not a major air pollutant but, on occasion, it can be a nuisance. It is measured continuously by the technique of chemiluminescence with unit data reported as hourly averages.

Sulphur Dioxide (SO_2) is a colourless gas with a pungent irritating odour. It is emitted primarily from the combustion of fossil fuels containing sulphur and from primary non-ferrous smelting. It is usually recognized as one of the major atmospheric pollutants. Sulphur dioxide causes an increased frequency of respiratory disease symptoms and lung disease. It also causes marked effects on vegetation, corrodes materials, and may oxidize in the atmosphere to form sulphuric acid and sulphates. Sulphur dioxide is the major contributor to the formation of acid rain. Sulphur dioxide is measured by use of the pulsed fluorescence technique with unit data reported as hourly averages.

Soiling Index (Smoke) (COH) is an indication of the soiling or darkening potential of fine particulate in the atmosphere usually resulting from combustion. These particles are usually in the size range of 0.1 to 1 micron in diameter. A tape sampler is used to collect the "smoke" particles on a filter paper and the degree of light transmission on an hourly basis is reported as Coefficient of Haze (COH) units.

Total Suspended Particulate (TSP) matter is a general term which applies to a large variety of inert solid or liquid particles of a size and configuration such that they remain suspended in the air and can be

drawn into the respiratory passages. These types of particles, usually in the size range of 0.1 to 100 microns (μm), may originate as a result of industrial processes, human activities and from natural sources such as wind swept or entrained dust. By itself, or in association with other pollutants, TSP, in enough concentration, may injure the respiratory system. TSP also may reduce visibility and contribute to property damage and soiling. A high volume air sampler is used to collect the particles on a Teflon or glass fibre filter and results are reported as integrated 24-hour concentration of mass of particulate matter per volume of air (volume-weighted).

Inhalable Particulate matter (PM_{10} and $PM_{2.5}$) is a fraction of the total suspended particulate found in the air. It is defined as the range of particles (solid and liquid) between 0.1 and 10 μm and 0.1 and 2.5 μm (respectively) in diameter that can penetrate into the tracheobronchial and alveolar regions of the lungs. A dichotomous sampler is used to collect the sample: a fine fraction less than 2.5 μm, and a coarse fraction between 2.5 and 10 μm. These two particulate sizes are combined to give the total for the inhalable particulate in a 24-hour period. A TEOM model 1400 PM_{10} monitor is also being used to give real time instantaneous readings at the Winnipeg downtown and residential stations, Flin Flon and Brandon. The PM_{10} instrument at the Winnipeg residential station was replaced with a $PM_{2.5}$ instrument in October 1997. Results are reported as hourly averages and the running 24-hour average is used for calculations in determining the Air Quality Index. In Flin Flon a size-selective Hi-Volume air sampler was used to sample inhalable particulates on a six day cycle.

Lead (Pb) exists in the atmosphere primarily as a particulate resulting from certain source industries and from entrainment of dust previously affected (by the combustion of leaded gasoline). Exposure to lead will adversely affect human health (especially young children) by absorption into the bloodstream and impairment of heme synthesis in cells. Other adverse effects associated with elevated blood lead levels include the possibility of nervous system damage. Lead is analyzed from a representative portion of the total suspended particulate collected by high volume sampling. Air concentrations are reported as integrated 24-hour concentrations of mass of lead per volume of air.

Other Heavy Metals: Copper (Cu), Cadmium (Cd), Zinc (Zn), and Arsenic (As) are constituents of TSP and are of interest in areas near point sources such as smelters. There are no Manitoba air quality Guidelines or Objectives for these substances. For evaluation purposes, Ontario's guidelines for these metals have been used where applicable.

Volatile Organic Compounds (VOCs) are a group of organic compounds in the alkaline, aromatic, alkyl halide and halogenated aromatic categories. Many of these are of concern due to their toxicity and role in photochemical oxidation. VOCs in combination with NO_x and sunlight produce ground level ozone (a major component of urban smog). Sampling is conducted over a 24-hour period once every sixth day. Stainless steel canisters are used for collection and the samples are analyzed by Environment Canada.

Polyaromatic Hydrocarbons (PAHs) are a group of organic compounds in the polycyclic aromatic category (2+ benzene rings fused together). Some of these are of concern due to their mutagenicity and carcinogenicity. Sampling was conducted over a 24-hour period once every twelve days. Teflon filters and Poly Urethane Foam (PUF) plug canisters are used for collection and the samples are analyzed by Environment Canada.

Polychlorinated Dibenzo-p-Dioxins (PCDDs) and Polychlorinated Dibenzo-p-Furans (PCDFs) are chemical compounds containing two benzene rings that are joined by two oxygen atoms in the case of dioxins and by one oxygen and a direct bond between the rings in the case of furans. Both molecules have eight positions which can be chlorinated. There are 75 possible chlorinated dibenzo-p-dioxin isomers ranging from 2 monochloro-species through 22 tetrachorospecies to 1 octachlorospecies. There are 135 possible chlorinated dibenzo-p-furan species The chlorinated dibenzo-p-dioxins and furans are formed as a pyrolysis product from chlorinated phenols. These compounds have been identified as part of the natural background in the environment. They have been identified as being part of the natural chemistry of fire, i.e., a natural wood fire will produce minute amounts of PCDDs and PCDFs. Of the dibenzo-p-dioxins the 2,3,7,8-tetrachlorodibenzo-p-dioxin isomer is the most toxic and is the one to which all the other isomers are compared to for a toxic equivalent factor (TEF). Of the 75 possible PCDDs only 7 have been identified as having a TEF similar to 2,37,8-TCDD. Of the 135 possible

PCDFs 10 have been identified with dioxin-like toxicity. These are the 17 compounds that are listed in Table 13. Sampling was conducted over a 24-hour period once every twelve days. Teflon filters and Poly Urethane Foam (PUF) plug canisters are used for collection and the samples are analyzed by Environment Canada.

Aldehydes and Ketones are aliphatic (straight or branched chain) or aromatic (containing a benzene ring) hydrocarbons which also contain a carbonyl (C=O) group in either the end position (in the case of aldehydes) or non-end position (as in the case of ketones). These chemicals are used in a variety of ways. They are solvents and intermediaries in the manufacture of other chemicals and substances. Certain of these compounds also find use as disinfectants, bactericides, fungicides and as flavouring and preserving agents. They are are all flammable and have distinctive odours. In high vapour concentrations many are irritants of the respiratory tract. Some of these compounds are also labelled as mutagens and possible carcinogens. Sampling for these compounds was conducted over a 24-hour period every six days. A pre-coated cartridge was used to collect the sample and analysis was done by Environment Canada.

C) SAMPLING SITES

Figure 1 is a map of the urban areas included in the Manitoba Ambient Air Quality Monitoring Network. Figures 2 through 5 depict the monitoring locations within each of the urban centres.

Air monitoring stations are listed in more detail in Table 2 as to location, code number, pollutants monitored, and monitoring period during 1997, 1998 and 1999.

TABLE 2 **AMBIENT AIR MONITORING SITES (1997-1999)**

AREA	CODE	SAMPLING SITE LOCATION	SAMPLING PERIOD	POLLUTANTS MONITORED
Winnipeg (Downtown) NAPS Station	9119	65 Ellen Street	Jan. - Dec.	CO, NO_2, NO, NO_x, O_3, TSP, PM_{10}, VOCs, Pb, $SO_4^=$, NO_3^-, COH, PAHs, PCDD/PCDFs & Carbonyls
Winnipeg (Residential) NAPS Station	9118	299 Scotia Street	Jan. - Dec.	CO, NO_2, NO, NO_x, O_3, COH, TSP, PM_{10}, $PM_{2.5}$, Pb, $SO_4^=$, NO_3^-
Brandon (Downtown) NAPS Station	9201	1104 Princess Avenue	Jan. - Dec.	TSP, Pb, $SO_4^=$, NO_3^-
Brandon (Industrial)	5131	Assiniboine Community College (Lot)	Jan. - Dec.	NH_3, NO_2, NO, NO_x, O_3, PM_{10}
Flin Flon	7251	Provincial Building, 143 Main Street	Jan. - Dec.	SO_2, TSP, NO_3^-, $SO_4^=$, PM_{10}, Pb, As, Cd, Cu, Zn
	7271*	Aqua Centre	Jan. - Dec.	SO_2
	7281*	HBM&S Staffhouse	Jan. - Dec.	SO_2
	7284*	Ruth Betts	Jan. - Dec.	TSP, As, Cd, Cu, Pb, Zn PM_{10}, & $SO_4^=$
	7285*	Sewage Plant	Jan. - Dec.	TSP, As, Cd, Cu, Pb, Zn PM_{10}, & $SO_4^=$
	7286*	Creighton, Sask. - School	From June /97	TSP, As, Cd, Cu, Pb, Zn
	7291*	Creighton, Sask. City Hall	Jan. - Dec.	SO_2
	7301*	Hapnot Collegiate	Jan. - Dec.	SO_2
Thompson	7351*	Thompson Water Treatment Plant	Jan. - Dec.	SO_2
Tilston	6111	Farm Yard #1 (9-6-29W)	July '98 - March '99	SO_2
	6112	Farm Yard #2 (4-6-29W)	April '99 - June '00	SO_2, H_2S
	6113	6-9 Well Site (8-8-6-29W)	April '99 - June '00	SO_2, H_2S

* denotes company supplied data

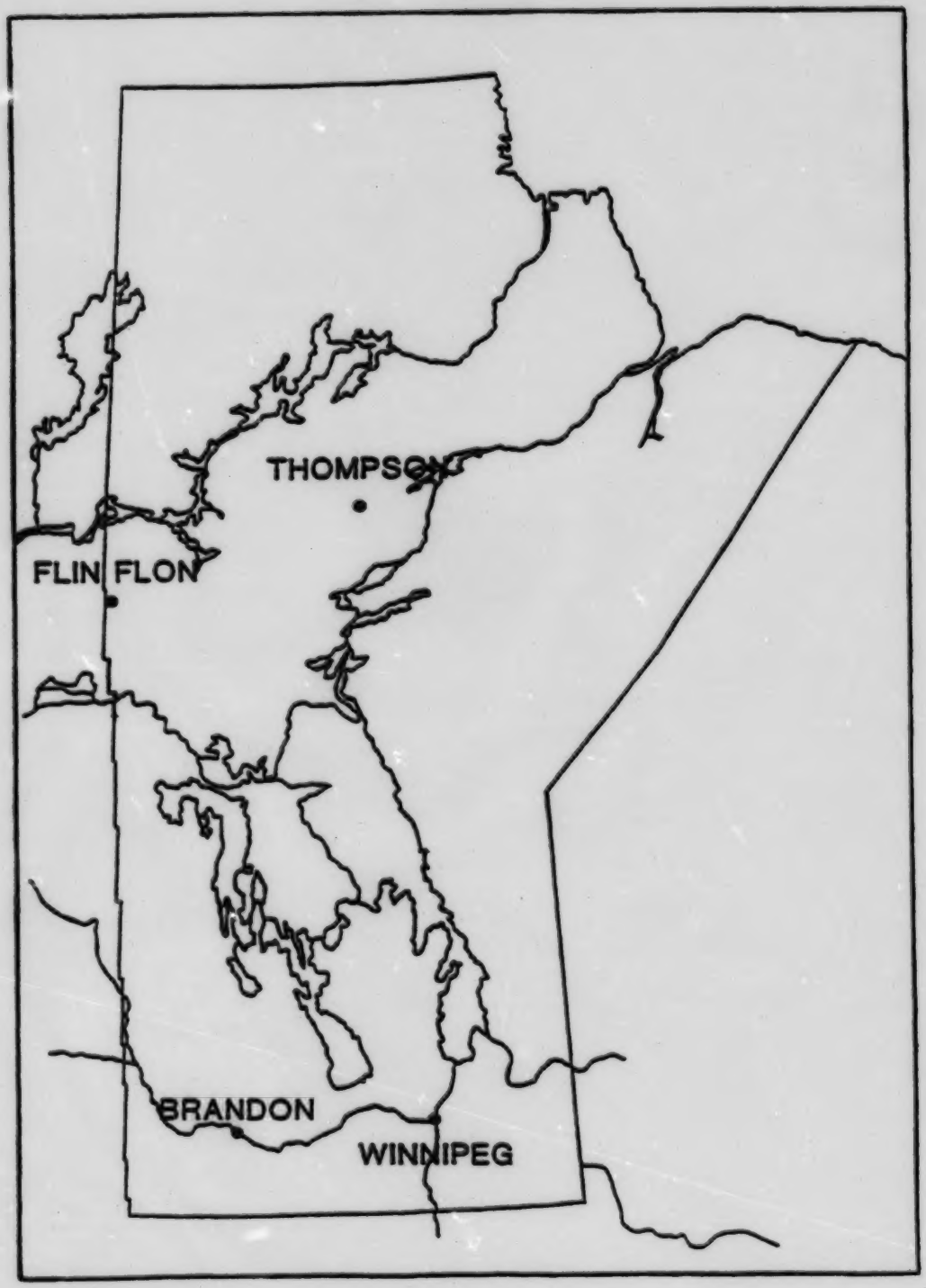

Figure 1. Urban Manitoba Ambient Air Quality Monitoring Network locations.

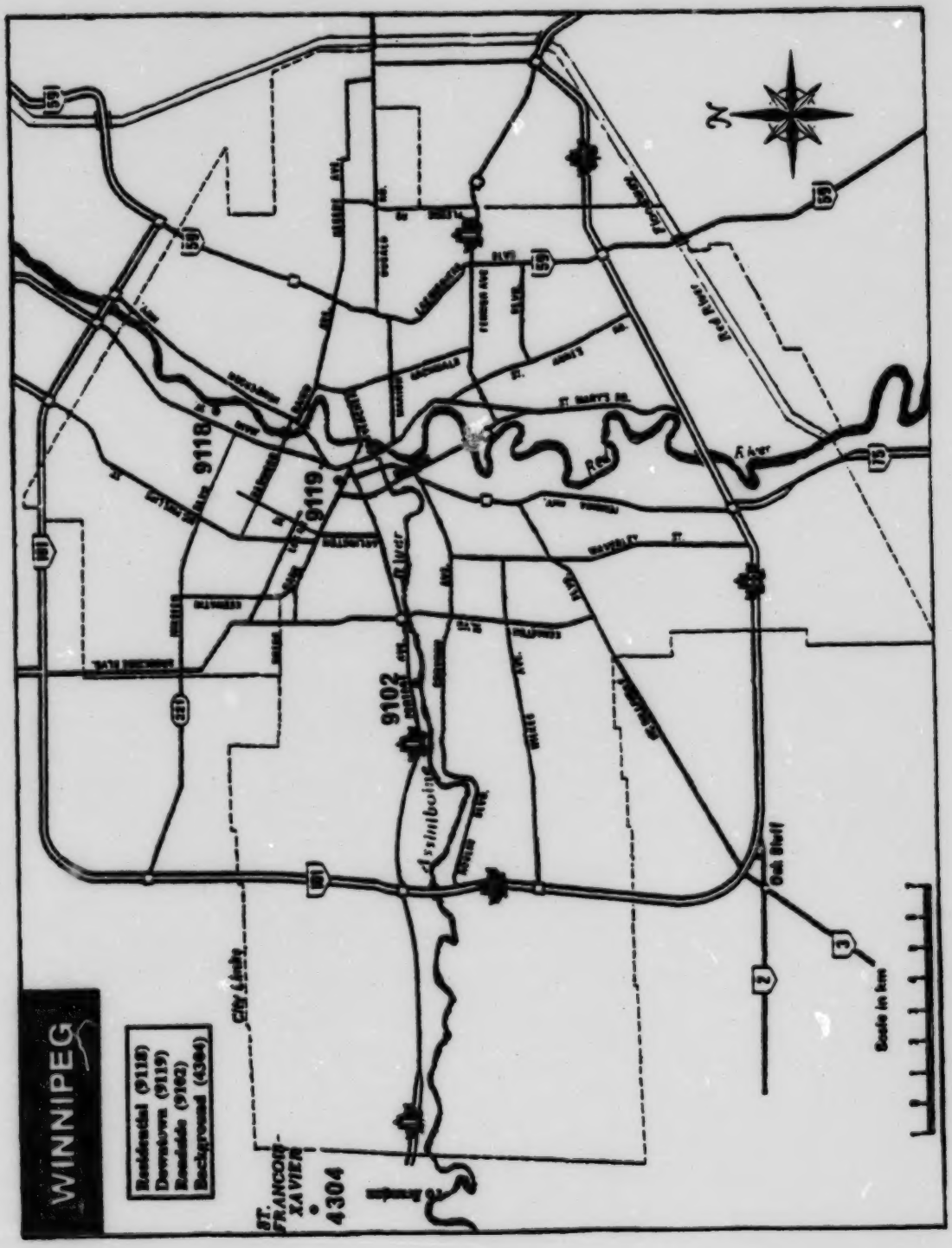

Figure 2. Winnipeg Ambient Air Monitoring Stations

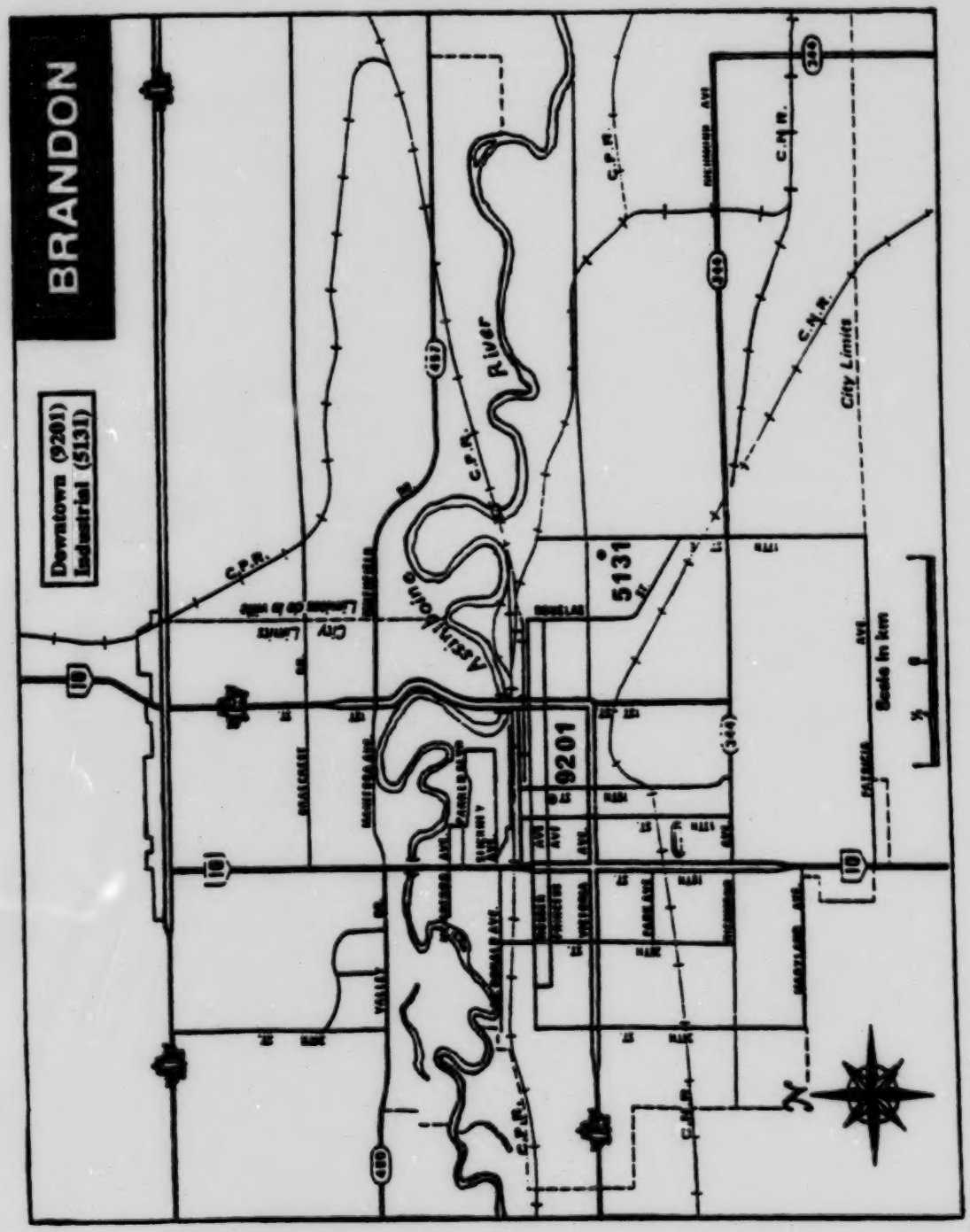

Figure 3. Brandon Ambient Air Monitoring Stations.

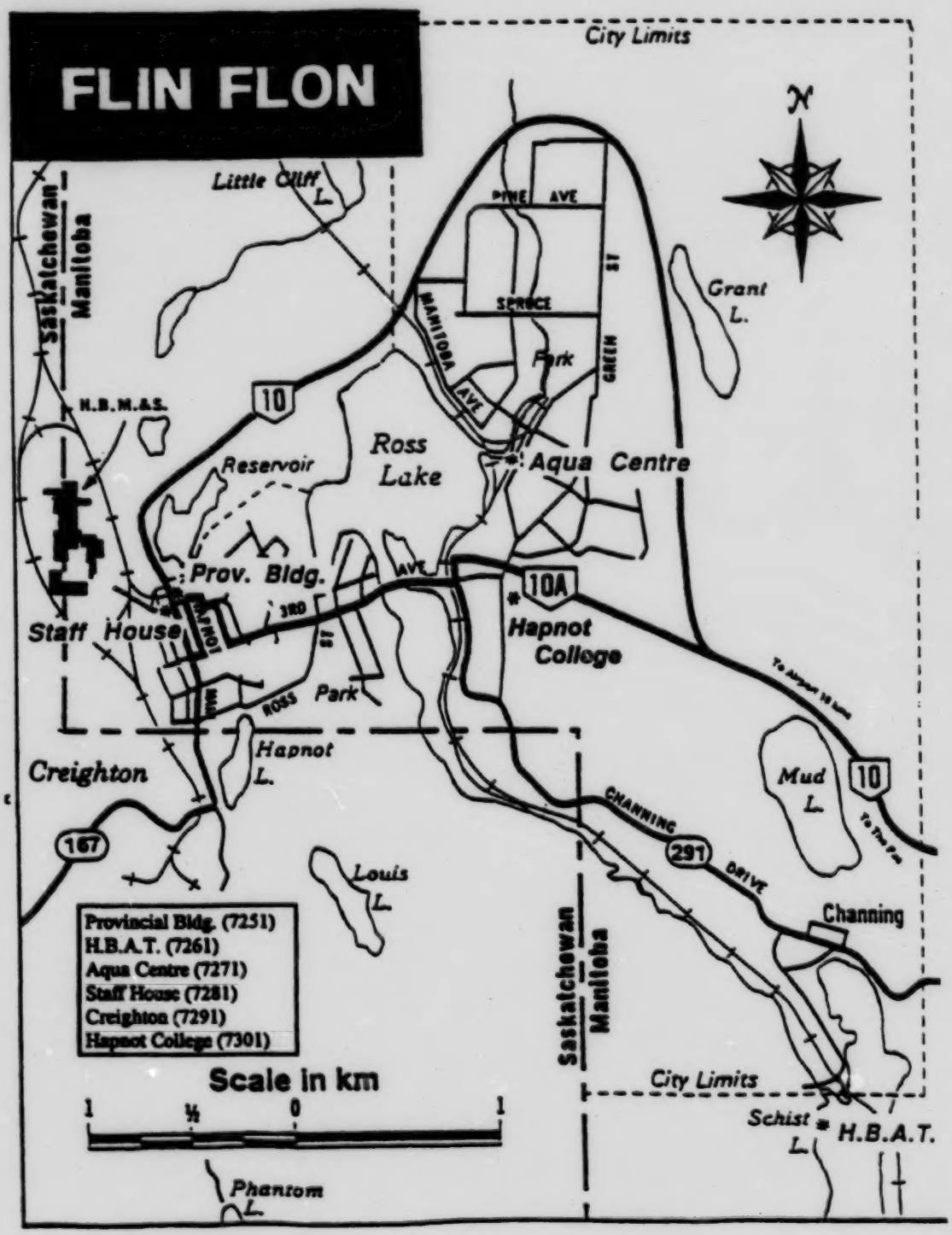

Figure 4. Flin Flon Ambient Air Monitoring Stations.

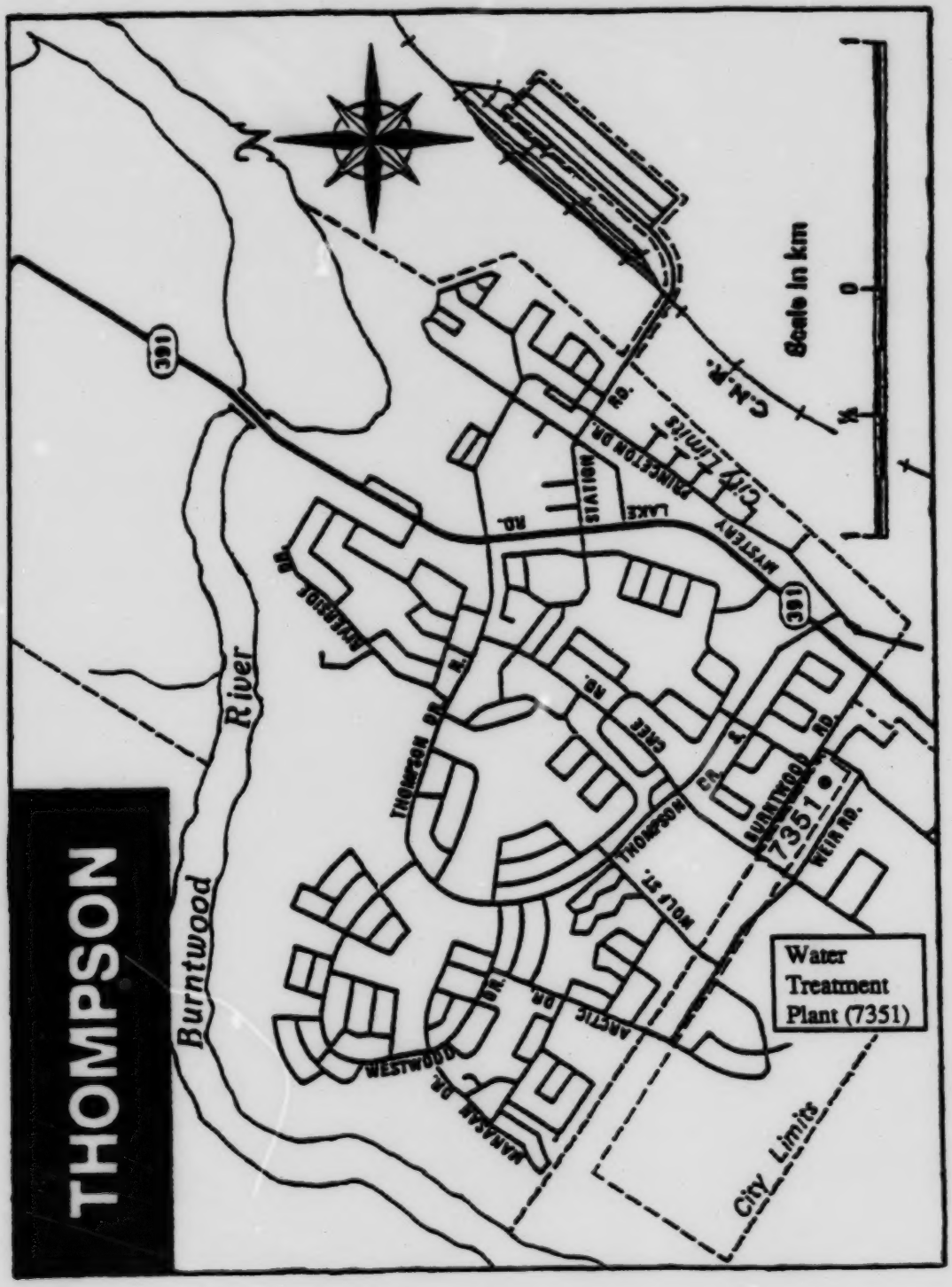

Figure 5. Thompson Ambient Air Monitoring Station.

D) THE INDEX OF THE QUALITY OF AIR (IQUA) or Air Quality Index (AQI)

The method for determining air quality indices is based on the Federal/Provincial draft document entitled "Guideline for the Index of the Quality of the Air (August 1993)". This document has been published in report form and can be obtained from Environment Canada (Report EPS 1/AP/3 April 1996). Formulas have been developed to assign air quality indices for all the pollutants for which National Objectives have been set. Although no objective currently exists for PM_{10}, a formula was developed based on the COH level. A general description of the IQUA is as follows:

SHORT TERM INDEX

The index is derived from Canadian National Air Quality Objectives and provides a scale consistent with all areas in Canada. Effects, such as on health, vegetation, and public perception, provide the bases for establishing the index. In some cases, the effects may not be easily observed by the general public.

Determining the Index

The concentrations of the individual pollutants are converted to a common scale such that an IQUA value of 0 corresponds to a zero level; a value of 25 to a level equal to the Maximum Desirable Air Quality Objective (MDL); a value of 50 to a level equal to the Maximum Acceptable Objective (MAL); and a value of 100 to a level equal to the Maximum Tolerable Objective (MTL). The maximum determined sub-index is the value of the IQUA. The index indicates the worst effect of the pollutants being monitored. The breakpoints between the various Objective levels describing the general air quality are shown as follows:

Breakpoint Description	Objective Level	Numerical Value
GOOD	MDL	25
FAIR	MAL	50
POOR	MTL	100

ANNUAL INDEX

The annual index is in the same form and consistent with the short term index. It reflects the long term air quality, indicates trends, and permits comparison with other areas in Canada. The annual index is the average value of the short term indices measured throughout the year.

Winnipeg's Air Quality Index:

The AQI is derived from valid air quality data from two National Air Pollution Surveillance (NAPS) Class 1 stations located in a residential area and a downtown area of Winnipeg. The index is designed to describe the general quality of air in urban centres, not the condition of the air downwind from a specific source of emission.

In the spring of 1995, Manitoba Environment in partnership with Environment Canada began dissemination of its monitoring data from the downtown station through the Air Quality Index (AQI) for Winnipeg. The data gathered at the downtown monitoring site is accessed by Environment Canada on an hourly basis and an AQI sub-index is calculated for each of the pollutants and the pollutant with the highest sub-index becomes that hour's determining factor and the value becomes the AQI. The AQI is available to the public in two ways: it can be accessed on Environment Canada's ATADs (Automated Telephone Answering Device - 204 983-2050) system; and by way of the local cable television network's Environment Canada weather channel.

RESULTS

EXPLANATION OF DATA STATISTICS

The summary statistics that appear on Tables 3 to 8 are designed to outline, in brief, a profile of annual air pollutant concentration levels at specific sites with comparison to Manitoba Air Quality Criteria, where applicable criteria are available.

Immediately below the pollutant is the indication of the units in which the air pollutant concentration levels are reported. Each air sampling site is identified by a station number and location. More information on the specific sampling site can be found by referring to Table 2.

The quantity of data available from which the calculated statistics are drawn is indicated by the two following references:

"# of months of data" - this refers to the number of months in the year for which at least 75% of the data are valid and available (not applicable to non-continuous measurements such as TSP, Pb, sulphates, and nitrates).

"Percent of data available" - this refers to the percentage of unit data (e.g. hourly averages) per year that are valid and available.

These two statistics are reflective of representativeness of the data statistics for that year. To representatively reflect annual air quality, two months of each quarter and 75% of the total annual data should be available for statistical calculation.

The "Percentile Distribution" is the data distribution of the unit data as shown (i.e. hourly for most pollutants, 24-hour integrated samples for TSP, PM_{10}, $PM_{2.5}$, Pb, $SO_4^{=}$, and NO_3^{-}. The pth percentile (e.g. 10%) is the pollutant concentration such that p% (e.g. 10%) of the data values are less than that indicated value of pollutant concentration and (100-p%) (e.g. 90%) are greater.

The annual mean is an arithmetic mean (unless otherwise shown) of the available unit data values. The maximum data values are the highest levels present or calculated for the time period listed within the

shown year. Other than for the unit data, longer time-based averages are arithmetic and are running averages of consecutive unit data and can overlap for days and/or months. For example, 24-hour running samples are based on increments of one hour and could result in a maximum of 24 hours/day x 365 days = 8760 24-hour sampling periods within a year. At least 75% of the data values within one running period must be available for the calculation of that running mean average.

A comparison of the data to the Manitoba Ambient Air Criteria (Table 1) is shown under the heading "# of Samples Above MDL/MAL/MTL". This listing is a count of the number of time-based averages or unit data concentrations that are larger than the appropriate time-based objective or guideline level.

Tables 3-8 show the statistical annual results of monitoring at the various stations during 1997-1999.

Tables 9-11 show the statistical analyses of the 24-hour average VOC samples collected in 1997-1999. The columns show the compound analyzed, the number of samples analyzed, the arithmetic mean, the standard deviation, the median, and the maximum and minimum values recorded during the year.

Table 12 shows the statistical analyses of the 24-hour average PAH samples collected in 1997-99. The columns show the compound analyzed, the number of samples analyzed, the arithmetic mean, the standard deviation, the median, and the maximum and minimum values recorded during the year.

Table 13 shows the statistical analyses of the 24-hour average polychlorinated dibenzodioxin/dibenzofuran samples collected for the period April 3, 1995 through to December 1999. The columns show the compound analyzed, the number of samples analyzed, the arithmetic mean, the standard deviation, the median, and the maximum and minimum values recorded during the five year period.

Table 14 shows the statistical analyses of the 24-hour average Aldehyde/ketone samples collected from March 11, 1997 through December 1999. The columns show the compound analyzed, the arithmetic mean, the median, the maximum and minimum values recorded during the three year period and the number of samples in which the compound or family of compounds were detected.

Table 3 **Manitoba Ambient Air Quality Data - 1997 Annual Pollutant Summary - Continuous Monitoring**

POLLUTANT Conc. Units	STATION NUMBER & LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES) 10%	30%	50%	70%	90%	99%	ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR	24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
CARBON MONOXIDE (CO) ppm	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.1%	0.2	0.2	0.3	0.4	0.6	1.8	0.37	4.1	2.9*	0	0*	0	0*	--	0*
	9119 WINNIPEG, 65 ELLEN STREET	12	95.4%	0.3	0.4	0.5	0.6	0.9	1.6	0.55	5.4	2.3*	0	0*	0	0*	--	0*
NITROGEN DIOXIDE (NO_2) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	11	87.0%	0.0	0.2	0.4	0.6	1.3	3.1	0.57	7.8	2.9	--	--	0	0	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.9%	0.3	0.6	0.9	1.4	2.6	5.2	1.22	9.6	4.6	--	--	0	0	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	94.3%	0.6	1.1	1.5	2.1	3.2	5.5	1.77	7.4	4.9	--	--	0	0	0	--
NITRIC OXIDE (NO) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	11	87.0%	0.0	0.0	0.1	0.3	0.8	5.0	0.40	35.2	8.7	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.9%	0.0	0.1	0.2	0.5	1.2	8.1	0.60	25.2	6.4	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	94.3%	0.1	0.3	0.6	1.1	2.6	7.9	1.15	31.2	7.3	--	--	--	--	--	--
NITROGEN OXIDES (NOx) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	11	87.0%	0.0	0.3	0.5	0.9	2.1	6.8	0.94	35.6	9.6	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.9%	0.3	0.6	1.0	1.6	3.7	12.8	1.74	29.5	9.4	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	94.3%	0.9	1.5	2.2	3.3	5.6	12.6	2.90	38.0	10.8	--	--	--	--	--	--
SULPHUR DIOXIDE (SO_2) ppm	7251 FLIN FLON, 143 MAIN STREET	12	94.5%	0.00	0.00	0.00	0.00	0.02	0.41	0.02	1.38	0.39	145	740	105	336	--	26
	7271* FLIN FLON, AQUA CENTRE	12	95.9%	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.25	0.04	2	0	0	0	--	0
	7281* FLIN FLON, HBM&S STAFFHOUSE	12	95.3%	0.00	0.00	0.00	0.00	0.02	0.30	0.01	0.94	0.44	181	490	70	124	--	16
	7291* CREIGHTON, SASK. CITY HALL	12	94.4%	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.71	0.07	30	44	7	0	--	0
	7301* FLIN FLON, HAPNOT COLLEGIATE	12	92.4%	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.65	0.09	19	21	4	0	--	0
	7351* THOMPSON, WATER TREATMENT PLANT	11	86.1%	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.67	0.07	23	16	5	0	--	0
OXIDANTS OZONE (O_3) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	94.0%	1.3	2.3	3.1	3.8	4.8	6.5	3.1	8.4	7.1	563	~	6	~	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.4%	0.5	1.4	2.1	2.8	3.9	5.7	2.2	7.5	5.2	174	~	0	~	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	95.4%	0.2	0.9	1.5	2.2	3.2	4.9	1.7	6.6	4.7	60	~	0	~	0	--
AMMONIA (NH_3) ppm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	93.8%	0.0	0.0	0.0	0.0	0.0	0.4	0.01	4.9	0.6	-	--	5	--	--	--
SOILING INDEX (COH) COH Units	9118 WINNIPEG, SCOTIA & JEFFERSON	12	97.6%	0.0	0.0	0.0	0.1	0.1	0.4	0.1	1.3	0.2	-	0	--	0	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	100%	0.0	0.0	0.1	0.1	0.2	0.4	0.1	1.4	0.3	--	0	--	0	--	--

* averaged over 8 hours • denotes company supplied data -- no guideline or objective ~ numerous exceedences of the 24 hour MDL and MAL which are currently under review

Table 4a **Manitoba Ambient Air Quality Data - 1997 Annual Pollutant Summary - Particulate Matter Monitoring (PM_{10})**

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.I. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.I. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.I. 1-HR	24-HR
INHALABLE PARTICULATE (PM_{10})	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	7	11	19	29	46	86	22 / 18[a]	86 /	--	--	--	--	--	--
	/251[4] FLIN FLON, 143 MAIN STREET	1-Hr	99.4%	3.3	6.0	10.5	18.3	45.0	145.5	19.5 / -	248.5 / 459.5	--	--	--	--	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	58	4	7	10	13	20	39	12 / 10	39 / -	--	--	--	--	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	59	4	5	7	9	15	42	9 / 7	42 /	--	--	--	--	--	--
	9118[4] WINNIPEG, SCOTIA & JEFFERSON	1-Hr	98.4%	4.8	9.3	13.8	21.0	37.5	99.8	19.0[a] / -	89.0 / 216.8	--	--	--	--	--	--
	9119[4] WINNIPEG, 65 ELLEN STREET	1-Hr	99.1%	6.5	10.8	16.0	25.0	44.5	87.3	21.8 / -	102.4 / 283.3	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	52	9.0	12.4	16.1	26.7	33.8	61.7	19.7 / 16.3	61.7 / -	--	--	--	--	--	--
	5131[4] BRANDON, ASSIN. COMMUN. COLLEGE	1-Hr	99.1%	3.5	7.0	11.0	17.0	32.0	97.5	15.8 / -	49 / 224.0	--	--	--	--	--	--
LEAD (Pb)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.03	0.04	0.04	0.26	1.40	2.39	0.36 / 0.12	2.39 / -	--	--	--	0	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.02	0.02	0.04	0.09	0.32	0.94	0.11 / 06	0.94 / -	--	--	--	0	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.02	0.02	0.02	0.03	0.12	0.28	0.05 / 0.04	0.28 / -	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.75	1.32	1.97	2.77	6.58	8.64	32.64 / -	8.64 / -	--	--	--	--	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.53	1.08	1.69	2.17	3.93	5.26	1.89 / -	5.26 / -	--	--	--	--	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.60	1.03	1.43	1.98	2.75	5.12	1.62 / -	5.12 / -	--	--	--	--	--	--
NITRATES (NO_3^-)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.02	0.04	0.10	0.14	0.32	0.75	0.13 / -	0.75 / -	--	--	--	--	--	--
ARSENIC (As)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.003	0.004	0.011	0.035	0.181	0.458	0.054 / 0.024	0.458 / -	--	--	--	2[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.000	0.001	0.003	0.009	0.029	0.079	0.011 / 0.003	0.079 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.000	0.000	0.001	0.006	0.010	0.040	0.005 / 0.002	0.040 / -	--	--	--	0[6]	--	--
CADMIUM (Cd)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.003	0.004	0.005	0.037	0.195	0.704	0.057 / 0.014	0.704 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.003	0.003	0.003	0.014	0.056	0.297	0.024 / 0.003	0.297 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.003	0.003	0.003	0.007	0.025	0.050	0.009 / 0.005	0.050 / -	--	--	--	0[6]	--	--
COPPER (Cu)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.146	0.200	0.310	0.543	0.987	2.312	0.472 / 0.345	2.312 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.006	0.014	0.051	0.108	0.227	0.577	0.094 / 0.041	0.577 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.006	0.008	0.021	0.066	0.143	0.354	0.056 / 0.026	0.354 / -	--	--	--	0[6]	--	--
ZINC (Zn)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	60	0.25	0.35	0.56	1.38	3.12	4.34	1.14 / 0.74	4.34 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	45	0.01	0.04	0.07	0.23	0.75	1.42	0.24 / 0.08	1.42 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	45	0.01	0.01	0.02	0.09	0.27	0.76	0.10 / 0.02	0.76 / -	--	--	--	0[6]	--	--

Notes: All Concentration units for the above Table 4a are in ug/m³. [a] - ARITHMETIC MEAN [g] - GEOMETRIC MEAN -- no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [2] - 24 Hour sample collected every three days, synchronized with the NAPS schedule [3] - 3 additional samples collected every NAPS cycle

[4] - real-time continuous monitoring [5] -replaced 10 um sampling head with 2.5 um head [6] Ontario 24-hour Criteria

Table 4b Manitoba Ambient Air Quality Data - 1997 Annual Pollutant Summary - Particulate Matter Monitoring ($PM_{2.5}$)

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
INHALABLE PARTICULATE ($PM_{2.5}$)	9118[4,5,6] WINNIPEG, SCOTIA & JEFFERSON	1-Hr	98.9%	0.3	1.7	2.9	4.9	9.2	18.4	4.2a / -	15.0 / 109.5	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	52	3.5	5.1	6.1	7.6	9.9	14.0	6.4 / 5.8	15.3 / -	--	--	--	--	--	--

Notes: All Concentration units for the above Table 4b are in ug/m^3. a - ARITHMETIC MEAN g - GEOMETRIC MEAN -- no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [2] - 24 Hour sample collected every three days, synchronized with the NAPS schedule [3] - 3 additional samples collected every NAPS cycle
[4] - real-time continuous monitoring [5] -replaced 10 um sampling head with 2.5 um head [6] - TEOM PM 2.5 data corrected to remove offset and slope factors as per NAPS directive.

Table 4c **Manitoba Ambient Air Quality Data - 1997 Annual Pollutant Summary - Particulate Matter Monitoring (TSP)**

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
TOTAL SUSPENDED PARTICULATE (TSP)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	10	16	31	51	95	136	42 / 428	156	--	--	--	3	--	0
	7283[1•] CREIGHTON, SCHOOL	24-Hr	61	10	13	19	27	43	131	25 / 22	131	--	--	--	1	--	0
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	119	7	11	17	31	49	82	24 / 14	98	--	--	--	0	--	0
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	110	6	10	13	19	36	59	17 / 14	61	--	--	--	0	--	0
	9118[1] WINNIPEG, 299 SCOTIA STREET	24-Hr	59	10	22	27	44	63	101	34 / 28	101	--	--	--	0	--	0
	9119[1,3] WINNIPEG, 65 ELLEN STREET	24-Hr	225	13	23	39	55	82	143	45 / 41	160	--	--	--	7	--	0
	9201[1] BRANDON, 1104 PRINCESS AVENUE	24-Hr	57	10	21	27	39	63	94	33 / 31	94	--	--	--	0	--	0
LEAD (Pb)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.03	0.03	0.05	0.22	1.28	2.55	0.34 / 0.11	2.98	--	--	--	0	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	61	0.02	0.02	0.03	0.03	0.17	0.64	0.06 / 0.04	0.64	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.02	0.02	0.03	0.09	0.34	1.91	0.14 / 0.13	1.91	--	--	--	0	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.02	0.02	0.02	0.05	0.17	1.34	0.07 / 0.04	1.34	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.75	1.46	1.94	2.92	7.62	14.43	3.14 / -	18.18	--	--	--	--	--	--
	72831•CREIGHTON, FIRE HALL	24-Hr	61	0.48	0.85	1.34	2.04	3.52	6.08	1.70 / -	6.08	--	--	--	--	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.61	1.14	1.80	2.32	3.98	9.01	2.10 / -	9.01	--	--	--	--	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.67	1.05	1.40	2.17	2.89	6.32	1.71 / -	6.32	--	--	--	--	--	--
NITRATES (NO_3^-)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.02	0.06	0.09	0.15	0.26	0.75	0.13 / -	0.92	--	--	--	--	--	--
ARSENIC (As)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.003	0.004	0.013	0.041	0.168	0.393	0.053 / 0.016	0.793	--	--	--	4	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	61	0.000	0.000	0.001	0.004	0.015	0.292	0.014 / 0.000	0.292	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.000	0.001	0.003	0.009	0.039	0.248	0.013 / 0.003	0.248	--	--	--	0	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.000	0.001	0.001	0.006	0.013	0.190	0.008 / 0.002	0.190	--	--	--	0	--	--
CADMIUM (Cd)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.003	0.003	0.005	0.025	0.166	0.396	0.049 / 0.012	0.656	--	--	--	0	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	61	0.003	0.003	0.003	0.003	0.026	0.136	0.010 / 0.004	0.136	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.003	0.003	0.003	0.015	0.067	0.303	0.024 / 0.009	0.303	--	--	--	0	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.003	0.003	0.003	0.007	0.029	0.121	0.010 / 0.006	0.121	--	--	--	0	--	--
COPPER (Cu)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.112	0.198	0.355	0.704	1.963	6.765	0.845 / 0.420	8.067	--	--	--	0	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	61	0.090	0.134	0.175	0.298	0.586	0.685	0.258 / 0.197	0.685	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.153	0.244	0.326	0.439	0.754	1.902	0.431 / 0.305	1.902	--	--	--	0	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.096	0.166	0.314	0.524	0.901	7.973	0.510 / 0.291	7.973	--	--	--	0	--	--
ZINC (Zn)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	117	0.23	0.39	0.79	1.77	4.79	9.05	1.71 / 0.58	10.87	--	--	--	0	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	61	0.01	0.01	0.03	0.14	0.29	1.76	0.15 / 0.04	1.76	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	90	0.01	0.06	0.15	0.44	1.36	5.03	0.47 / 0.13	5.03	--	--	--	0	--	--
	7285[1•] FLIN FLON, CENTOBA/SEWAGE PLANT	24-Hr	83	0.01	0.02	0.07	0.20	0.63	2.95	0.24 / 0.06	2.95	--	--	--	0	--	--

Notes: All Concentration units for the above Table 4c are in ug/m^3. * - ARITHMETIC MEAN ** - GEOMETRIC MEAN -- no guideline or objective •- company supplied data

[1] - 24 Hour sample collected every six days according to NAPS schedule [2] - 24 Hour sample collected every three days, synchronized with the NAPS schedule [3] - 3 additional samples collected every NAPS cycle

[•] - real-time continuous monitoring

Table 5 **Manitoba Ambient Air Quality Data - 1998 Annual Pollutant Summary - Continuous Monitoring**

POLLUTANT Conc. Units	STATION NUMBER & LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES) 10%	30%	50%	70%	90%	99%	ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR	24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
CARBON MONOXIDE (CO) ppm	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.0%	0.2	0.3	0.3	0.4	0.6	1.8	0.4	5.8	4.0*	0	0*	0	0*	--	0*
	9119 WINNIPEG, 65 ELLEN STREET	12	94.9%	0.3	0.4	0.5	0.6	0.9	1.8	0.6	5.6	2.5*	0	0*	0	0*	--	0*
NITROGEN DIOXIDE (NO_2) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	95.1%	0.2	0.4	0.6	1.0	1.7	3.5	0.8	6.5	3.1	--	--	0	0	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.6%	0.3	0.5	0.9	1.4	2.6	4.2	1.2	5.7	4.0	--	--	0	0	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.7%	0.6	1.0	1.5	2.1	3.2	5.1	1.7	8.2	6.0	--	--	0	0	0	--
NITRIC OXIDE (NO) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	95.1%	0.0	0.0	0.1	0.3	1.0	5.6	0.5	29.7	5.1	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.6%	0.0	0.1	0.1	0.2	1.3	9.7	0.6	41.0	12.5	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.7%	0.2	0.3	0.6	1.1	2.9	10.2	1.2	30.9	10.4	--	--	--	--	--	--
NITROGEN OXIDES (NOx) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	95.1%	0.3	0.5	0.8	1.3	2.6	8.2	1.3	34.4	7.4	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.6%	0.3	0.5	0.9	1.6	3.8	13.2	1.7	51.6	15.5	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.7%	0.8	1.4	2.1	3.2	5.9	14.9	2.9	37.4	14.6	--	--	--	--	--	--
SULPHUR DIOXIDE (SO_2) ppm	7251 FLIN FLON, 143 MAIN STREET	12	95.2%	0.00	0.00	0.00	0.00	0.02	0.29	0.01	1.21	0.29	184	531	64	179	--	0
	7271• FLIN FLON, AQUA CENTRE	12	95.5%	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.45	0.09	23	25	5	0	--	0
	7281• FLIN FLON, HBM&S STAFFHOUSE	12	94.7%	0.00	0.00	0.00	0.00	0.00	0.26	0.01	1.00	0.21	154	373	55	132	--	0
	7291• CREIGHTON, SASK. CITY HALL	12	94.3%	0.00	0.00	0.00	0.00	0.00	0.15	0.01	0.70	0.13	67	95	11	26	--	0
	7301• FLIN FLON, HAPNOT COLLEGIATE	12	95.4%	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.94	0.12	34	44	12	9	--	0
	7351• THOMPSON, WATER TREATMENT PLANT	12	96.1%	0.00	0.00	0.00	0.00	0.00	0.06	0.00	1.03	0.11	22	30	8	0	--	0
OXIDANTS OZONE (O_3) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	95.5%	1.4	2.2	2.8	3.3	4.3	5.6	2.8	6.7	4.9	227	~	0	~	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	94.8%	0.6	1.6	2.3	3.0	4.0	5.5	2.3	7.2	4.9	200	~	0	~	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	94.9%	0.2	0.8	1.4	2.0	2.9	4.3	1.5	6.5	3.4	15	~	0	~	0	--
AMMONIA (NH_3) ppm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	95.1%	0.0	0.0	0.0	0.0	0.0	0.2	0.00	3.1	0.4	--	--	2	--	--	--
SOILING INDEX (COH) COH Units	9118 WINNIPEG, SCOTIA & JEFFERSON	12	97.6	0.0	0.0	0.0	0.1	0.2	0.4	0.06	1.0	0.5	--	6	--	0	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	97.6	0.0	0.0	0.1	0.1	0.2	0.4	0.07	0.9	0.3	--	0	--	0	--	--

* averaged over 8 hours • denotes company supplied data -- no guideline or objective ~ numerous exceedences of the 24 hour MDL and MAL which are currently under review

Table 6a **Manitoba Ambient Air Quality Data - 1998 Annual Pollutant Summary - Particulate Matter Monitoring (PM_{10})**

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
INHALABLE PARTICULATE (PM_{10})	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	8	14	20	31	76	205	31 / 22	205 / -	--	--	--	--	--	--
	7251[4] FLIN FLON, 143 MAIN STREET	1-Hr	99.8%	4.0	7.3	11.5	21.3	59.3	183.8	24.3 / 24.3	181.4 / 430.5	--	--	--	--	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	53	5.4	8.5	12.4	21.1	32.1	51.4	16.0 / 13	51.4 / -	--	--	--	--	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	59	3.3	6.6	10.3	14.0	24.0	49.8	12.0 / 10	49.8 / -	--	--	--	--	--	--
	9119[4] WINNIPEG, 65 ELLEN STREET	1-Hr	98.9%	7.5	11.5	16.3	24.5	42.3	93.3	22.0 /	101.5 / 210.5	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	59	7.3	10.1	13.0	20.2	34.3	47.2	17.6 / 14.8	47.2 / -	--	--	--	--	--	--
	5131[4] BRANDON, ASSIN. COMMUN. COLLEGE	1-Hr	97.3%	3.8	7.8	13.0	23.8	53	146.0	23.1 /	127.0 / 382.8	--	--	--	--	--	--
LEAD (Pb)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.04	0.04	0.05	0.17	1.56	8.37	0.515 / 0.110	8.370 / -	--	--	--	2	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	10	0.065	0.199	0.447	0.834	3.090	3.090	0.809 / 0.375	3.092 / -	--	--	--	0	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	12	0.024	0.025	0.108	0.201	1.610	1.823	0.365 / 0.107	1.823 / -	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.61	0.66	1.26	1.97	6.28	13.82	2.44 / -	13.82 / -	--	--	--	--	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	7	0.058	2.284	2.326	2.391	2.701	2.701	1.753 / -	2.701 / -	--	--	--	--	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	9	0.062	0.615	1.912	2.112	2.496	2.496	1.500 / -	2.496 / -	--	--	--	--	--	--
NITRATES (NO_3)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.06	0.06	0.07	0.12	0.24	1.19	0.13 /	1.19 / -	--	--	--	--	--	--
ARSENIC (As)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.003	0.005	0.007	0.028	0.333	1.105	0.090 / 0.014	1.105 / -	--	--	--	7[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	10	0.017	0.041	0.072	0.080	0.322	0.322	0.091 / 0.046	0.322 / -	--	--	--	1[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	12	0.003	0.004	0.021	0.028	0.128	0.218	0.040 / 0.013	0.218 / -	--	--	--	0[6]	--	--
CADMIUM (Cd)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.004	0.004	0.005	0.019	0.216	1.023	0.071 / 0.012	1.023 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	10	0.003	0.022	0.092	0.189	0.323	0.323	0.107 / 0.037	0.323 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	12	0.003	0.003	0.020	0.029	0.149	0.162	0.037 / 0.013	0.162 / -	--	--	--	0[6]	--	--
COPPER (Cu)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.173	0.252	0.347	0.573	2.051	3.896	0.712 / 0.453	3.896 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	10	0.152	0.286	0.444	0.525	1.033	1.033	0.417 / 0.315	1.033 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	12	0.024	0.065	0.131	0.185	0.301	0.316	0.138 / 0.086	0.316 / -	--	--	--	0[6]	--	--
ZINC (Zn)	7251[1] FLIN FLON, 143 MAIN STREET	24-Hr	58	0.16	0.22	0.32	0.71	4.01	8.37	1.151 / 0.513	8.37 / -	--	--	--	0[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	10	0.310	0.464	0.906	1.270	2.770	2.770	0.975 / 0.709	2.77 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	12	0.030	0.054	0.259	0.343	0.800	1.180	0.326 / 0.149	1.18 / -	--	--	--	0[6]	--	--

Notes: All Concentration units for the above Table 4a are in ug/m^3. * - ARITHMETIC MEAN * - GEOMETRIC MEAN -- no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [4] - real-time continuous monitoring [6] - Ontario 24-hour Criteria

Table 6b Manitoba Ambient Air Quality Data - 1998 Annual Pollutant Summary - Particulate Matter Monitoring ($PM_{2.5}$)

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
INHALABLE PARTICULATE ($PM_{2.5}$)	9118[4,5] WINNIPEG, SCOTIA & JEFFERSON	1-Hr	98.4%	0.8	2.9	4.7	7.1	13.4	30.6	6.4 /	62.1 / 140.9	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	59	2.9	4.8	6.5	7.8	11.3	20.1	6.9 / 6.0	21.5 / -	--	--	--	--	--	--

Notes: All Concentration units for the above Table 4b are in ug/m^3. * - ARITHMETIC MEAN *- GEOMETRIC MEAN - - no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [4] - real-time continuous monitoring [5] - TEOM PM 2.5 data corrected to remove offset and slop factors as per NAPS directive

Table 6c Manitoba Ambient Air Quality Data - 1998 Annual Pollutant Summary - Particulate Matter Monitoring (TSP)

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
TOTAL SUSPENDED PARTICULATE (TSP)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	9	25	39	67	136	200	58 / 37	377	--	--	--	13	--	--
	7283[1•] CREIGHTON, SCHOOL	24-Hr	119	9	17	21	33	53	80	28 / 18	157	--	--	--	1	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	119	7	12	20	33	55	87	27 / 16	97	--	--	--	0	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	109	6	10	13	20	42	55	18 / 13	74	--	--	--	0	--	--
	9118[1] WINNIPEG, 299 SCOTIA STREET	24-Hr	59	11	18	26	38	62	179	34 / 26	179	--	--	--	1	--	--
	9119[1,3] WINNIPEG, 65 ELLEN STREET	24-Hr	220	16	27	41	58	88	160	48 / 40	178	--	--	--	10	--	--
	9201[1] BRANDON, 1104 PRINCESS AVENUE	24-Hr	58	10	18	28	43	75	108	35 / 27	108	--	--	--	0	--	--
LEAD (Pb)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.03	0.03	0.04	0.15	1.14	6.46	0.47 / 0.10	9.93	--	--	--	2	--	--
	7283[1•] CREIGHTON, SCHOOL	24-Hr	119	0.02	0.02	0.02	0.05	0.19	0.82	0.08 / 0.07	1.22	--	--	--	0	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	27	0.05	0.15	0.45	0.57	1.98	3.09	0.65 / 0.31	3.09	--	--	--	0	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	23	0.02	0.05	0.13	0.21	0.38	1.16	0.19 / 0.14	1.16	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.54	0.96	1.37	2.65	7.11	13.81	2.90 / -	27.43	--	--	--	--	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	103	0.33	0.85	1.88	2.83	3.84	4.54	1.98 / -	8.82	--	--	--	--	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	21	1.62	2.15	2.77	3.57	4.80	6.51	3.00 / -	6.51	--	--	--	--	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	20	0.56	0.95	1.78	2.06	2.98	3.35	1.68 / -	3.35	--	--	--	--	--	--
NITRATES (NO_3^-)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.05	0.06	0.08	0.12	0.25	0.46	0.13 / -	1.82	--	--	--	--	--	--
ARSENIC (As)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.003	0.005	0.010	0.039	0.266	0.809	0.085 / 0.017	1.045	--	--	--	10[6]	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	119	0.000	0.001	0.003	0.010	0.047	0.080	0.013 / 0.010	0.205	--	--	--	0[6]	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	27	0.003	0.019	0.031	0.070	0.204	0.363	0.067 / 0.053	0.363	--	--	--	1[6]	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	23	0.003	0.007	0.015	0.033	0.056	0.073	0.023 / 0.020	0.073	--	--	--	0[6]	--	--
CADMIUM (Cd)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.003	0.003	0.004	0.020	0.127	0.766	0.057 / 0.011	0.895	--	--	--	0[6]	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	119	0.003	0.003	0.003	0.005	0.025	0.100	0.010 / 0.042	0.104	--	--	--	0[6]	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	27	0.004	0.016	0.040	0.086	0.244	0.281	0.077 / 0.063	0.281	--	--	--	0[6]	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	23	0.003	0.003	0.016	0.033	0.047	0.107	0.022 / 0.019	0.107	--	--	--	0[6]	--	--
COPPER (Cu)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.075	0.170	0.293	0.723	2.735	7.038	1.015 / 0.385	11.757	--	--	--	0[6]	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	119	0.074	0.113	0.162	0.233	0.348	1.011	0.197 / 0.206	1.027	--	--	--	0[6]	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	27	0.289	0.605	0.787	1.190	1.962	2.442	0.984 / 0.793	2.442	--	--	--	0[6]	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	23	0.180	0.313	0.478	0.655	0.777	1.261	0.513 / 0.473	1.143	--	--	--	0[6]	--	--
ZINC (Zn)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	107	0.19	0.30	0.45	1.60	5.36	13.61	1.87 / 0.746	14.96	--	--	--	0[6]	--	--
	7283[1•] CREIGHTON, FIRE HALL	24-Hr	119	0.006	0.022	0.070	0.219	0.649	1.590	0.208 / 0.105	2.316	--	--	--	0[6]	--	--
	7284[1•] FLIN FLON, RUTH BETTS	24-Hr	27	0.255	0.640	0.930	1.540	3.142	3.885	1.363 / 0.856	3.885	--	--	--	0[6]	--	--
	7285[1•] FLIN FLON, SEWAGE PLANT	24-Hr	23	0.108	0.192	0.355	0.567	1.572	1.75	0.527 / 0.366	1.750	--	--	--	0[6]	--	--

Notes: All Concentration units for the above Table 4c are in ug/m^3. * - ARITHMETIC MEAN * - GEOMETRIC MEAN -- no guideline or objective •- company supplied data

[1] - 24 Hour sample collected every six days according to NAPS schedule [2] - 24 Hour sample collected every three days, synchronized with the NAPS schedule [3] - 3 additional samples collected every NAPS cycle
[4] - real-time continuous monitoring [6] - Ontario 24-hour Criteria

Table 7 **Manitoba Ambient Air Quality Data - 1999 Annual Pollutant Summary - Continuous Monitoring**

POLLUTANT Conc. Units	STATION NUMBER & LOCATION	# OF MONTHS AVAIL.	PERCENT OF DATA AVAIL.	PERCENTILE DISTRIBUTION (1-HOUR SAMPLES) 10%	30%	50%	70%	90%	99%	ANNUAL MEAN	MAXIMUM DATA VALUES 1-HR	24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
CARBON MONOXIDE (CO) ppm	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.3%	0.2	0.2	0.3	0.3	0.6	1.5	0.34	6.9	3.1*	0	0*	0	0*	--	0*
	9119 WINNIPEG, 65 ELLEN STREET	12	95.1%	0.3	0.4	0.5	0.6	0.8	1.6	0.55	5.5	3.0*	0	0*	0	0*	--	0*
NITROGEN DIOXIDE (NO_2) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	80.5%	0.3	0.5	0.7	1.0	1.7	3.6	0.88	6.6	3.3	--	--	0	0	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.0%	0.3	0.5	0.9	1.4	2.7	4.4	1.21	7.7	4.2	--	--	0	0	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.9%	0.5	1.0	1.5	2.1	3.5	5.5	1.77	12.9	6.0	--	--	0	0	0	--
NITRIC OXIDE (NO) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	80.5%	0.0	0.0	0.0	0.7	1.4	5.2	0.54	18.3	6.5	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.0%	0.0	0.0	0.1	0.2	1.4	9.2	0.61	54.5	12.6	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.9%	0.1	0.3	0.6	1.1	2.7	8.8	1.11	50.5	10.0	--	--	--	--	--	--
NITROGEN OXIDES (NOx) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	80.5%	0.1	0.5	1.0	1.5	2.7	8.0	1.33	20.8	9.5	--	--	--	--	--	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.0%	0.3	0.6	0.9	1.6	4.0	12.6	1.75	60.7	15.8	--	--	--	--	--	--
	9119 WINNIPEG, 65 ELLEN STREET	12	93.9%	0.7	1.4	2.1	3.3	5.7	12.7	2.86	63.3	12.6	--	--	--	--	--	--
SULPHUR DIOXIDE (SO_2) ppm	7251 FLIN FLON, 143 MAIN STREET	12	68.7%	0.00	0.00	0.00	0.00	0.00	0.41	0.02	1.85	0.41	174	445	80	216	--	20
	7271* FLIN FLON, AQUA CENTRE	12	95.8%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0	0	0	0	--	0
	7281* FLIN FLON, HBM&S STAFFHOUSE	12	95.8%	0.00	0.00	0.0	0.00	0.00	0.32	0.01	0.86	0.26	177	468	77	160	--	0
	7291* CREIGHTON, SASK. CITY HALL	12	95.1%	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.45	0.09	39	22	7	0	--	0
	7301* FLIN FLON, HAPNOT COLLEGIATE	12	95.5%	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.59	0.06	25	0	1	0	--	0
	7351* THOMPSON, WATER TREATMENT PLANT	12	99.7%	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.68	0.07	29	39	8	0	--	0
OXIDANTS OZONE (O_3) pphm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	89.8%	1.1	2.0	2.8	3.5	4.4	5.9	2.78	8.9	6.5	279	~	5	~	0	--
	9118 WINNIPEG, SCOTIA & JEFFERSON	12	95.3%	0.6	1.5	2.2	2.9	3.9	5.7	2.27	7.1	5.5	233	~	0	~	0	--
	9119 WINNIPEG, 65 ELLEN STREET	12	83.4%	0.2	0.7	1.4	2.2	3.3	4.9	1.62	6.5	4.8	64	~	0	~	0	--
AMMONIA (NH_3) ppm	5131 BRANDON, ASSIN. COMMUN. COLLEGE	12	89.6%	0.0	0.0	0.0	0.0	0.0	0.6	0.02	3.0	0.6	--	--	6	--	--	--
SOILING INDEX (COH) COH Units	9118 WINNIPEG, SCOTIA & JEFFERSON	6.5	52.5%	0.0	0.0	0.0	0.0	0.1	0.2	0.01	0.6	0.1	--	0	--	0	--	--
	9119 WINNIPEG, 65 ELLEN STREET	7.6	63.1%	0.0	0.0	0.0	0.0	0.1	0.1	0.02	0.6	0.1	--	0	--	0	--	--

* averaged over 8 hours • denotes company supplied data -- no guideline or objective ~ numerous exceedences of the 24 hour MDL and MAL which are currently under review

Table 8a Manitoba Ambient Air Quality Data - 1999 Annual Pollutant Summary - Particulate Matter Monitoring (PM_{10})

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
INHALABLE PARTICULATE (PM_{10})	7251[4] FLIN FLON, 143 MAIN STREET	1-Hr	99.3%	4.5	7.8	12.0	21.0	53.5	176.8	23.5 / -	157.5 / 500.8	--	--	--	33[6]	--	--
	7284[1] FLIN FLON, RUTH BETTS	24-Hr	59	5.7	8.1	10.2	14.0	25.8	43.8	14 / 11	44 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	60	4.1	7.0	9.2	10.9	24.1	41.7	11 / 9	41 / -	--	--	--	0[6]	--	--
	9119[4] WINNIPEG, 65 ELLEN STREET	1-Hr	90.9%	8.0	12.0	16.3	23.0	40.3	82.0	21.4 / -	114.7 / 433.3	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	58	7.8	12.3	17.1	25.8	31.9	87.6	22.7 / 18.1	111.8 / -	--	--	--	2[6]	--	--
	5131[4] BRANDON, ASSIN. COMMUN. COLLEGE	1-Hr	98.0%	4.0	8.0	12.8	21.8	45.0	112.3	21.2 / -	153.4 / 499.0	--	--	--	--	--	--
LEAD (Pb)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.025	0.086	0.223	0.689	0.889	3.519	0.597 / 0.221	3.516 / -	--	--	--	0	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.025	0.060	0.173	0.195	0.773	1.831	0.295 / 0.129	1.831 / -	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.552	0.801	1.639	2.706	3.049	10.055	2.308 / 1.464	10.055 / -	--	--	--	--	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.251	1.035	1.423	2.024	2.635	2.922	1.465 / 1.101	2.922 / -	--	--	--	--	--	--
ARSENIC (As)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.001	0.010	0.055	0.071	0.080	0.099	0.042 / 0.020	0.099 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.001	0.003	0.016	0.024	0.057	0.117	0.025 / 0.008	0.117 / -	--	--	--	0[6]	--	--
CADMIUM (Cd)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.003	0.003	0.033	0.069	0.123	0.331	0.064 / 0.021	0.331 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.003	0.003	0.010	0.024	0.058	0.090	0.022 / 0.011	0.090 / -	--	--	--	0[6]	--	--
COPPER (Cu)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.060	0.061	0.141	0.238	0.496	0.940	0.232 / 0.147	0.940 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.024	0.049	0.102	0.128	0.237	0.267	0.110 / 0.083	0.267 / -	--	--	--	0[6]	--	--
ZINC (Zn)	7284[1] FLIN FLON, RUTH BETTS	24-Hr	12	0.025	0.161	0.354	0.660	1.001	3.353	0.602 / 0.236	3.353 / -	--	--	--	0[6]	--	--
	7285[1] FLIN FLON, SEWAGE PLANT	24-Hr	14	0.006	0.146	0.203	0.250	0.801	0.886	0.249 / 0.113	0.886 / -	--	--	--	0[6]	--	--

Notes: All Concentration units for the above Table 4a are in ug/m^3. * - ARITHMETIC MEAN ^ - GEOMETRIC MEAN -- no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [4] - real time continuous monitoring [6] - Ontario 24-hour guideline

Table 8b Manitoba Ambient Air Quality Data - 1999 Annual Pollutant Summary - Particulate Matter Monitoring ($PM_{2.5}$)

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24/1-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
INHALABLE PARTICULATE ($PM_{2.5}$)	9118[4,5] WINNIPEG, SCOTIA & JEFFERSON	1-Hr	98.1%	0.8	2.7	4.4	6.6	11.5	23.3	5.5 / -	21.2 / 65.8	--	--	--	--	--	--
	9119[1] WINNIPEG, 65 ELLEN STREET	24-Hr	58	3.7	5.4	6.4	7.7	15.0	32.9	8.2 / 6.9	45.5 / -	--	--	--	--	--	--

Notes: All Concentration units for the above Table 4b are in ug/m^3. * - ARITHMETIC MEAN ^ - GEOMETRIC MEAN -- no guideline or objective

[1] - 24 Hour sample collected every six days according to NAPS schedule [4] - real-time continuous monitoring [5] - $PM_{2.5}$ data corrected to remove offset and slope factors as per NAPS directive

Table 8c **Manitoba Ambient Air Quality Data - 1999 Annual Pollutant Summary - Particulate Matter Monitoring (TSP)**

POLLUTANT	STATION NUMBER & LOCATION	Collection Duration	% Data or # OF SAMPLES	PERCENTILE DISTRIBUTION 10%	30%	50%	70%	90%	99%	ANNUAL ARITH/GEO MEAN	MAXIMUM DATA VALUES 24-HR	# OF SAMPLES ABOVE M.D.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.A.L. 1-HR	24-HR	# OF SAMPLES ABOVE M.T.L. 1-HR	24-HR
TOTAL SUSPENDED PARTICULATE (TSP)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	10	21	39	64	97	222	50 / 35	307	--	--	--	13	--	--
	7283[1*] CREIGHTON, SCHOOL	24-Hr	118	9.5	14.9	19.8	27.0	46.9	96.1	25 / 21	114	--	--	--	0	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	120	8.9	13.8	21.2	30.7	57.5	107.3	28 / 22	135	--	--	--	1	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	119	6.8	9.8	13.5	19.1	43.1	183.1	21 / 15	235	--	--	--	2	--	--
	9118[1] WINNIPEG, 299 SCOTIA STREET	24-Hr	58	11	17	25	32	55	213	32 / 26	213	--	--	--	1	--	--
	9119[1,3] WINNIPEG, 65 ELLEN STREET	24-Hr	224	17	31	44	57	82	181	50 / 41	199	--	--	--	11	--	--
	9201[1] BRANDON, 1104 PRINCESS AVENUE	24-Hr	44	16	23	36	43	66	95	37 / 32	95	--	--	--	0	--	--
LEAD (Pb)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.03	0.03	0.06	0.20	1.20	6.77	0.48 / 0.11	13.11	--	--	--	5	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.023	0.024	0.032	0.069	0.315	0.717	0.10 / 0.05	0.72	--	--	--	0	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.024	0.125	0.240	0.612	1.294	2.525	0.50 / 0.22	2.53	--	--	--	0	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.023	0.046	0.159	0.285	0.908	1.618	0.33 / 0.14	1.62	--	--	--	0	--	--
SULPHATES ($SO_4^=$)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.53	1.01	1.69	3.10	7.78	17.95	3.27 / 1.91	28.22	--	--	--	--	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.896	1.206	1.561	1.985	3.000	6.316	1.795 / 1.532	6.32	--	--	--	--	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.882	1.518	2.277	2.969	5.943	7.743	2.534 / 1.901	7.74	--	--	--	--	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.638	1.050	1.574	2.474	2.281	4.584	1.873 / 1.436	4.58	--	--	--	--	--	--
NITRATES (NO_3^-)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.05	0.06	0.11	0.19	0.47	0.98	0.189 / 0.126	1.31	--	--	--	--	--	--
ARSENIC (As)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.002	0.005	0.012	0.036	0.188	0.852	0.066 / 0.016	1.38	--	--	--	10[6]	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.000	0.003	0.007	0.012	0.048	0.081	0.014 / 0.006	0.081	--	--	--	0[6]	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.001	0.013	0.039	0.066	0.122	0.167	0.050 / 0.023	0.167	--	--	--	0[6]	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.000	0.004	0.019	0.029	0.107	0.256	0.035 / 0.010	0.256	--	--	--	0[6]	--	--
CADMIUM (Cd)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.003	0.003	0.005	0.022	0.136	0.586	0.050 / 0.011	0.896	--	--	--	0[6]	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.003	0.003	0.003	0.005	0.017	0.085	0.009 / 0.005	0.085	--	--	--	0[6]	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.003	0.007	0.023	0.055	0.124	0.467	0.056 / 0.022	0.467	--	--	--	0[6]	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.003	0.003	0.013	0.031	0.113	0.160	0.033 / 0.014	0.160	--	--	--	0[6]	--	--
COPPER (Cu)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.086	0.182	0.336	0.701	1.925	4.261	0.682 / 0.363	5.726	--	--	--	0[6]	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.115	0.254	0.296	0.439	0.591	2.092	0.365 / 0.297	2.092	--	--	--	0[6]	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.153	0.550	0.681	1.022	2.211	2.804	0.879 / 0.637	2.804	--	--	--	0[6]	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.220	0.500	0.661	0.770	0.991	1.541	0.655 / 0.558	1.541	--	--	--	0[6]	--	--
ZINC (Zn)	7251[2] FLIN FLON, 143 MAIN STREET	24-Hr	218	0.13	0.25	0.52	1.34	4.51	8.64	1.467 / 1.623	14.500	--	--	--	0[6]	--	--
	7283[1*] CREIGHTON, FIRE HALL	24-Hr	54	0.006	0.057	0.142	0.266	0.656	2.498	0.272 / 0.115	2.498	--	--	--	0[6]	--	--
	7284[1*] FLIN FLON, RUTH BETTS	24-Hr	37	0.084	0.369	0.840	1.248	2.051	3.788	0.997 / 0.556	3.788	--	--	--	0[6]	--	--
	7285[1*] FLIN FLON, SEWAGE PLANT	24-Hr	35	0.006	0.131	0.434	0.573	1.669	2.394	0.539 / 0.230	2.394	--	--	--	0[6]	--	--

Notes: All Concentration units for the above Table 4b are in ug/m^3. * - ARITHMETIC MEAN * - GEOMETRIC MEAN -- no guideline or objective *-- company supplied data

[1] - 24 Hour sample collected every six days according to NAPS schedule [2] - 24 Hour sample collected every three days, synchronized with the NAPS schedule [3] - 3 additional samples collected every NAPS cycle

[4] - real-time continuous monitoring [5] - Ontario 24-hour Guideline

Table 9 VOC Concentrations (µg/m³) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1997.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
Ethane	55	3.67	1.48	3.45	7.45	1.27
Ethylene	55	3.17	1.53	2.84	10.38	0.82
Acetylene	55	4.34	2.55	3.78	17.77	0.84
Propylene	55	1.22	0.56	1.18	3.74	0.40
Propane	55	4.38	2.10	4.02	10.36	1.37
Isobutane	55	2.11	1.21	1.91	7.78	0.73
1-Butene/Isobutene	55	1.06	0.36	0.98	2.66	0.55
1,3-Butadiene	55	0.24	0.11	0.22	0.74	0.07
Butane	55	5.21	3.25	4.76	19.88	1.32
trans-2-Butene	55	0.17	0.08	0.15	0.52	0.00
2,2-Dimethylpropane	55	0.05	0.02	0.04	0.12	0.00
1-Butyne	55	0.00	0.01	0.00	0.04	0.00
cis-2-Butene	55	0.17	0.08	0.16	0.46	0.05
Isopentane	55	4.36	2.13	3.92	11.74	1.66
1-Pentene	55	0.24	0.11	0.22	0.64	0.06
2-Methyl-1-butene	55	0.19	0.13	0.16	0.52	0.02
Pentane	55	1.87	0.91	1.72	5.16	0.65
Isoprene	48	0.55	0.76	0.21	3.48	0.00
trans-2-Pentene	55	0.20	0.17	0.16	1.15	0.05
cis-2-Pentene	55	0.27	0.14	0.24	0.83	0.10
2-Methyl-2-butene	55	0.58	0.34	0.53	2.42	0.20
2,2-Dimethylbutane	55	0.31	0.16	0.27	1.02	0.12
Cyclopentene	55	0.09	0.04	0.08	0.25	0.04
4-Methyl-1-pentene	55	0.01	0.03	0.00	0.11	0.00
3-Methyl-1-pentene	55	0.02	0.04	0.00	0.16	0.00
Cyclopentane	55	0.29	0.16	0.24	0.98	0.10
2,3-Dimethylbutane	55	0.43	0.27	0.38	1.78	0.15
trans-4-Methyl-2-pentene	55	0.05	0.11	0.00	0.57	0.00
2-Methylpentane	55	1.92	1.08	1.64	7.88	0.78
cis-4-Methyl-2-pentene	55	0.04	0.07	0.00	0.28	0.00
3-Methylpentane	55	1.02	0.80	0.86	6.02	0.34
1-Hexene	55	0.28	0.15	0.24	0.73	0.06
n-Hexane	55	0.95	0.89	0.72	6.78	0.31
trans-2-Hexene	55	0.06	0.04	0.06	0.22	0.02
2-Ethyl-1-Butene	55	0.02	0.03	0.00	0.19	0.00
trans-3-Methyl-2-pentene	55	0.05	0.06	0.04	0.34	0.00
cis-2-Hexene	55	0.04	0.05	0.04	0.29	0.00
cis-3-Methyl-2-pentene	55	0.08	0.05	0.06	0.39	0.00
2,2-Dimethylpentane	55	0.06	0.05	0.05	0.34	0.00
Methylcyclopentane	55	0.60	0.36	0.56	2.28	0.21
2,4-Dimethylpentane	55	0.33	0.22	0.29	1.45	0.11
1-Methylcyclopentene	55	0.12	0.06	0.11	0.42	0.02
Benzene	55	1.48	0.65	1.40	4.12	0.49
Cyclohexane	55	0.18	0.09	0.18	0.52	0.04
2-Methylhexane	55	0.59	0.42	0.50	2.94	0.19
2,3-Dimethylpentane	55	0.77	0.46	0.67	3.13	0.27
Cyclohexene	46	0.06	0.04	0.06	0.13	0.00
3-Methylhexane	55	0.57	0.38	0.51	2.52	0.18
1-Heptene	55	0.14	0.46	0.00	2.65	0.00

Table 9 VOC Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1997.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
2,2,4-Trimethylpentane	55	0.90	0.52	0.82	3.84	0.32
trans-3-Heptene	55	0.00	0.01	0.00	0.05	0.00
cis-3-Heptene	55	0.01	0.03	0.00	0.21	0.00
Heptane	55	0.51	0.34	0.44	2.34	0.19
trans-2-Heptene	55	0.01	0.02	0.00	0.09	0.00
cis-2-Heptene	55	0.03	0.06	0.00	0.21	0.00
2,2-Dimethylhexane	55	0.03	0.02	0.03	0.10	0.00
Methylcyclohexane	55	0.24	0.14	0.24	0.86	0.08
2,5-Dimethylhexane	55	0.11	0.07	0.10	0.51	0.04
2,4-Dimethylhexane	55	0.16	0.09	0.15	0.58	0.06
2,3,4-Trimethylpentane	55	0.30	0.18	0.28	1.20	0.11
Toluene	55	5.81	4.03	4.68	20.79	1.52
2-Methylheptane	54	0.22	0.11	0.22	0.60	0.00
1-Methylcyclohexene	55	0.07	0.04	0.07	0.14	0.00
4-Methylheptane	54	0.11	0.07	0.10	0.29	0.00
3-Methylheptane	55	0.29	0.17	0.27	1.05	0.08
cis-1,3-Dimethylcyclohexane	55	0.08	0.05	0.08	0.33	0.00
trans-1,4-Dimethylcyclohexane	55	0.02	0.02	0.00	0.08	0.00
2,2,5-Trimethylhexane	55	0.02	0.03	0.00	0.14	0.00
1-Octene	50	0.02	0.05	0.00	0.22	0.00
Octane	55	0.21	0.11	0.18	0.62	0.09
trans-1,2-Dimethylcyclohexane	55	0.05	0.04	0.04	0.20	0.00
trans-2-Octene	55	0.04	0.04	0.04	0.14	0.00
cis-1,4/t-1,3-Dimethylcyclohexane	55	0.02	0.02	0.02	0.12	0.00
cis-2-Octene	55	0.02	0.03	0.00	0.10	0.00
Ethylbenzene	55	0.84	0.51	0.76	3.28	0.23
m and p-Xylene	55	2.96	1.82	2.52	10.44	0.68
Styrene	48	0.46	0.91	0.18	5.67	0.00
o-Xylene	55	1.03	0.61	0.88	3.78	0.29
1-Nonene	43	0.01	0.04	0.00	0.18	0.00
Nonane	55	0.22	0.11	0.20	0.68	0.09
iso-Propylbenzene	55	0.05	0.02	0.05	0.16	0.02
3,6-Dimethyloctane	55	0.02	0.02	0.00	0.10	0.00
n-Propylbenzene	55	0.15	0.08	0.12	0.58	0.06
3-Ethyltoluene	55	0.46	0.30	0.42	1.90	0.08
4-Ethyltoluene	55	0.24	0.15	0.20	1.00	0.06
1,3,5-Trimethylbenzene	55	0.26	0.16	0.24	0.80	0.00
2-Ethyltoluene	55	0.19	0.12	0.16	0.76	0.04
1-Decene	48	0.08	0.26	0.00	1.26	0.00
tert-Butylbenzene	55	0.00	0.01	0.00	0.03	0.00
1,2,4-Trimethylbenzene	55	0.82	0.56	0.72	3.12	0.04
Decane	55	0.27	0.15	0.24	0.94	0.06
iso-Butylbenzene	55	0.02	0.02	0.02	0.08	0.00
sec-Butylbenzene	55	0.02	0.02	0.02	0.08	0.00
1,2,3-Trimethylbenzene	55	0.22	0.14	0.19	0.72	0.00
p-Cymene	55	0.06	0.06	0.04	0.30	0.00
Indane	55	0.10	0.06	0.09	0.34	0.00
1,3-Diethylbenzene	55	0.05	0.03	0.05	0.16	0.00
1,4-Diethylbenzene	55	0.23	0.16	0.20	0.69	0.00

Table 9 VOC Concentrations (µg/m³) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1997.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
n-Butylbenzene	55	0.04	0.03	0.04	0.14	0.00
1,2-Diethylbenzene	55	0.02	0.02	0.02	0.06	0.00
Undecane	55	0.19	0.12	0.18	0.60	0.00
Naphthalene	55	0.48	0.43	0.33	1.76	0.00
Dodecane	55	0.10	0.06	0.09	0.27	0.00
Hexylbenzene	55	0.01	0.02	0.00	0.08	0.00
Freon22	55	0.67	0.33	0.58	2.50	0.26
Chloromethane	55	1.04	0.13	1.01	1.42	0.86
Freon114	55	0.19	0.06	0.19	0.32	0.10
Vinylchloride	55	0.01	0.01	0.00	0.04	0.00
Bromomethane	55	0.13	0.05	0.14	0.22	0.06
Chloroethane	55	0.08	0.04	0.08	0.20	0.00
Freon11	55	1.92	0.90	1.80	8.29	1.42
Freon12	55	2.94	0.42	2.81	4.06	2.38
Ethylbromide	55	0.02	0.02	0.00	0.09	0.00
1,1-Dichloroethylene	55	0.04	0.03	0.04	0.10	0.00
Dichloromethane	55	1.78	2.97	0.98	20.63	0.28
Freon113	55	0.73	0.07	0.73	0.94	0.61
trans-1,2-Dichloroethylene	55	0.02	0.02	0.01	0.07	0.00
1,1-Dichloroethane	55	0.03	0.03	0.04	0.07	0.00
cis-1,2-Dichloroethylene	55	0.03	0.02	0.04	0.07	0.00
Chloroform	55	0.13	0.04	0.13	0.23	0.07
1,2-Dichloroethane	55	0.06	0.03	0.06	0.12	0.02
1,1,1-Trichloroethane	55	0.58	0.09	0.58	0.87	0.42
2,2,3-Trimethylbutane	55	0.00	0.01	0.00	0.05	0.00
Carbontetrachloride	55	0.68	0.09	0.69	0.93	0.44
Dibromomethane	55	0.08	0.04	0.08	0.17	0.02
1,2-Dichloropropane	55	0.01	0.02	0.00	0.06	0.00
Bromodichloromethane	55	0.05	0.04	0.06	0.12	0.00
Trichloroethylene	55	0.38	0.30	0.32	1.78	0.04
cis-1,3-Dichloropropene	55	0.00	0.00	0.00	0.00	0.00
trans-1,3-Dichloropropene	55	0.00	0.00	0.00	0.02	0.00
1,1,2-Trichloroethane	55	0.02	0.03	0.00	0.10	0.00
Bromotrichloromethane	55	0.00	0.00	0.00	0.00	0.00
Dibromochloromethane	55	0.03	0.03	0.04	0.11	0.00
EDB	55	0.03	0.03	0.00	0.11	0.00
Tetrachloroethene	55	0.64	0.52	0.50	2.18	0.08
Chlorobenzene	55	0.02	0.02	0.02	0.08	0.00
Bromoform	55	0.04	0.02	0.04	0.09	0.01
1,4-Dichlorobutane	55	0.00	0.00	0.00	0.00	0.00
1,1,2,2-Tetrachloroethane	55	0.03	0.03	0.02	0.09	0.00
Benzylchloride	55	0.00	0.00	0.00	0.00	0.00
1,3-Dichlorobenzene	55	0.00	0.00	0.00	0.00	0.00
1,4-Dichlorobenzene	55	0.09	0.04	0.08	0.22	0.02
1,2-Dichlorobenzene	55	0.00	0.00	0.00	0.00	0.00
1,2,4-Trichlorobenzene	55	0.00	0.00	0.00	0.00	0.00
Hexachlorobutadiene	55	0.00	0.00	0.00	0.00	0.00

The average detection limit varies between 0.5 and 1 µg/m³.

Table 10 VOC Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1998.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
Ethane	50	4.18	1.71	3.90	11.52	1.97
Ethylene	50	3.27	1.88	2.86	9.38	1.33
Acetylene	50	3.21	1.94	2.83	10.38	0.94
Propylene	50	1.04	0.46	0.99	2.34	0.28
Propane	50	4.02	2.24	3.45	12.31	1.20
Isobutane	50	1.92	0.95	1.65	4.52	0.50
1-Butene/Isobutene	50	0.92	0.29	0.87	1.52	0.28
1,3-Butadiene	50	0.19	0.1	0.18	0.47	0.00
Butane	50	4.51	2.53	3.93	11.04	0.83
trans-2-Butene	50	0.15	0.07	0.14	0.40	0.04
2,2-Dimethylpropane	50	0.02	0.01	0.02	0.05	0.00
1-Butyne	50	0.00	0	0.00	0.02	0.00
cis-2-Butene	50	0.16	0.07	0.14	0.37	0.04
Isopentane	50	4.04	1.91	3.61	9.89	1.20
1-Pentene	50	0.21	0.11	0.19	0.57	0.06
2-Methyl-1-butene	50	0.16	0.12	0.12	0.52	0.00
Pentane	50	1.71	0.76	1.46	4.36	0.53
Isoprene	43	0.66	1.12	0.26	6.23	0.10
trans-2-Pentene	50	0.14	0.08	0.12	0.43	0.04
cis-2-Pentene	50	0.28	0.14	0.26	0.80	0.06
2-Methyl-2-butene	50	0.53	0.24	0.47	1.22	0.19
2,2-Dimethylbutane	50	0.24	0.1	0.22	0.57	0.09
Cyclopentene	50	0.06	0.03	0.06	0.14	0.02
4-Methyl-1-pentene	50	0.01	0.02	0.00	0.07	0.00
3-Methyl-1-pentene	50	0.02	0.04	0.00	0.25	0.00
Cyclopentane	50	0.23	0.11	0.20	0.59	0.07
2,3-Dimethylbutane	50	0.35	0.14	0.33	0.84	0.12
trans-4-Methyl-2-pentene	47	0.06	0.08	0.04	0.30	0.00
2-Methylpentane	50	1.38	0.53	1.29	3.12	0.48
cis-4-Methyl-2-pentene	50	0.07	0.06	0.07	0.20	0.00
3-Methylpentane	50	0.81	0.33	0.79	2.09	0.26
1-Hexene	50	0.18	0.15	0.14	0.56	0.00
n-Hexane	50	0.82	0.33	0.80	2.01	0.27
trans-2-Hexene	50	0.05	0.03	0.04	0.16	0.02
2-Ethyl-1-Butene	50	0.03	0.02	0.03	0.11	0.01
trans-3-Methyl-2-pentene	50	0.04	0.03	0.04	0.15	0.00
cis-2-Hexene	50	0.03	0.03	0.03	0.12	0.00
cis-3-Methyl-2-pentene	50	0.07	0.04	0.06	0.19	0.02
2,2-Dimethylpentane	50	0.04	0.02	0.04	0.11	0.00
trans-1,2-Dichloroethylene	50	0.00	0.01	0.00	0.02	0.00
Methylcyclopentane	50	0.54	0.22	0.53	1.39	0.18
2,4-Dimethylpentane	50	0.27	0.12	0.24	0.63	0.09
2,2,3-Trimethylbutane	50	0.00	0.01	0.00	0.02	0.00
1-Methylcyclopentene	50	0.11	0.05	0.10	0.30	0.04
Benzene	50	1.41	0.54	1.32	2.94	0.53
Cyclohexane	50	0.15	0.08	0.13	0.42	0.04
2-Methylhexane	50	0.47	0.19	0.43	1.08	0.16
2,3-Dimethylpentane	50	0.61	0.27	0.54	1.40	0.23
Cyclohexene	50	0.02	0.02	0.02	0.07	0.00

Table 10 VOC Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1998.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
3-Methylhexane	50	0.42	0.21	0.36	1.19	0.16
1-Heptene	42	0.14	0.3	0.00	1.00	0.00
2,2,4-Trimethylpentane	50	0.77	0.37	0.66	1.86	0.26
trans-3-Heptene	50	0.00	0	0.00	0.01	0.00
cis-3-Heptene	46	0.00	0.01	0.00	0.05	0.00
Heptane	50	0.44	0.2	0.41	0.96	0.14
trans-2-Heptene	50	0.01	0.02	0.00	0.06	0.00
cis-2-Heptene	50	0.01	0.03	0.00	0.14	0.00
2,2-Dimethylhexane	50	0.01	0.01	0.02	0.04	0.00
Methylcyclohexane	50	0.25	0.13	0.22	0.81	0.06
2,5-Dimethylhexane	50	0.13	0.07	0.10	0.32	0.03
2,4-Dimethylhexane	50	0.13	0.06	0.11	0.27	0.04
2,3,4-Trimethylpentane	50	0.23	0.11	0.20	0.54	0.00
Toluene	50	5.80	3.49	4.90	15.99	1.39
2-Methylheptane	50	0.19	0.09	0.18	0.45	0.06
1-Methylcyclohexene	50	0.07	0.03	0.06	0.14	0.00
4-Methylheptane	50	0.08	0.04	0.08	0.20	0.00
3-Methylheptane	50	0.19	0.09	0.17	0.39	0.00
cis-1,3-Dimethylcyclohexane	50	0.07	0.03	0.06	0.12	0.02
trans-1,4-Dimethylcyclohexane	50	0.03	0.02	0.03	0.09	0.00
2,2,5-Trimethylhexane	50	0.03	0.02	0.03	0.09	0.00
1-Octene	31	0.03	0.03	0.02	0.10	0.00
Octane	50	0.16	0.07	0.15	0.34	0.06
trans-1,2-Dimethylcyclohexane	50	0.04	0.02	0.04	0.10	0.00
trans-2-Octene	50	0.00	0.01	0.00	0.06	0.00
cis-1,4/t-1,3-Dimethylcyclohexane	50	0.03	0.01	0.03	0.08	0.00
cis-2-Octene	42	0.00	0	0.00	0.00	0.00
Ethylbenzene	50	0.74	0.41	0.66	2.35	0.24
m and p-Xylene	50	2.72	1.5	2.48	8.54	0.79
Styrene	28	0.37	0.69	0.18	3.48	0.00
o-Xylene	50	0.96	0.51	0.88	3.21	0.30
Nonane	42	0.19	0.08	0.18	0.38	0.06
iso-Propylbenzene	50	0.04	0.02	0.04	0.10	0.02
3,6-Dimethyloctane	50	0.02	0.02	0.02	0.06	0.00
n-Propylbenzene	50	0.13	0.06	0.12	0.31	0.04
3-Ethyltoluene	50	0.44	0.21	0.40	1.16	0.15
4-Ethyltoluene	50	0.23	0.1	0.22	0.57	0.08
1,3,5-Trimethylbenzene	50	0.25	0.12	0.23	0.62	0.09
2-Ethyltoluene	50	0.18	0.08	0.16	0.43	0.06
1-Decene	8	0.00	0	0.00	0.00	0.00
tert-Butylbenzene	50	0.00	0.01	0.00	0.02	0.00
1,2,4-Trimethylbenzene	50	0.79	0.38	0.71	2.08	0.26
Decane	50	0.30	0.16	0.27	0.86	0.08
iso-Butylbenzene	50	0.02	0.01	0.02	0.04	0.00
sec-Butylbenzene	50	0.02	0.01	0.02	0.04	0.00
1,2,3-Trimethylbenzene	50	0.20	0.1	0.18	0.50	0.06
p-Cymene	50	0.03	0.03	0.04	0.10	0.00
1,2-Dichlorobenzene	50	0.00	0	0.00	0.00	0.00
Indane	50	0.10	0.04	0.10	0.24	0.04

Table 10 VOC Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1998.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
1,3-Diethylbenzene	50	0.05	0.02	0.05	0.12	0.02
1,4-Diethylbenzene	50	0.18	0.09	0.17	0.48	0.06
n-Butylbenzene	50	0.04	0.02	0.03	0.11	0.00
1,2-Diethylbenzene	50	0.01	0.01	0.02	0.04	0.00
Undecane	50	0.21	0.11	0.18	0.67	0.06
Naphthalene	50	0.25	0.15	0.23	0.74	0.04
Dodecane	50	0.08	0.04	0.08	0.20	0.00
Hexylbenzene	50	0.02	0.03	0.00	0.09	0.00
Freon22	50	0.62	0.51	0.52	3.93	0.27
Chloromethane	50	1.03	0.12	1.03	1.40	0.80
Freon114	50	0.14	0.02	0.13	0.21	0.10
Vinylchloride	50	0.00	0	0.00	0.01	0.00
Bromomethane	50	0.08	0.02	0.08	0.13	0.06
Chloroethane	50	0.04	0.03	0.04	0.14	0.00
Freon11	50	1.68	0.12	1.65	2.08	1.42
Freon12	50	3.37	3.12	2.79	24.40	2.19
Ethylbromide	50	0.00	0	0.00	0.02	0.00
1,1-Dichloroethylene	50	0.01	0.01	0.00	0.04	0.00
Dichloromethane	50	1.58	1.81	0.83	9.85	0.28
Freon113	50	0.71	0.06	0.70	0.92	0.58
1,1-Dichloroethane	50	0.00	0.01	0.00	0.03	0.00
cis-1,2-Dichloroethylene	50	0.00	0.01	0.00	0.04	0.00
Chloroform	50	0.13	0.04	0.12	0.24	0.08
1,2-Dichloroethane	50	0.04	0.01	0.04	0.06	0.02
1,1,1-Trichloroethane	50	0.46	0.04	0.46	0.56	0.38
Carbontetrachloride	50	0.65	0.05	0.66	0.76	0.50
trans-1,3-Dichloropropene	50	0.00	0	0.00	0.00	0.00
Dibromomethane	50	0.04	0.01	0.04	0.07	0.02
1,2-Dichloropropane	50	0.00	0	0.00	0.00	0.00
Bromodichloromethane	50	0.01	0.02	0.00	0.07	0.00
Trichloroethylene	50	0.34	0.31	0.28	1.96	0.02
cis-1,3-Dichloropropene	50	0.00	0	0.00	0.00	0.00
1,1,2-Trichloroethane	50	0.00	0	0.00	0.02	0.00
Bromotrichloromethane	41	0.00	0	0.00	0.00	0.00
Dibromochloromethane	50	0.01	0.01	0.01	0.04	0.00
EDB	50	0.00	0.01	0.00	0.03	0.00
Tetrachloroethene	50	0.84	0.94	0.51	4.98	0.09
Chlorobenzene	50	0.03	0.01	0.03	0.04	0.01
Bromoform	50	0.03	0.01	0.02	0.04	0.00
1,4-Dichlorobutane	50	0.00	0	0.00	0.00	0.00
1,1,2,2-Tetrachloroethane	50	0.01	0.01	0.00	0.04	0.00
Benzylchloride	50	0.00	0.01	0.00	0.04	0.00
1,3-Dichlorobenzene	50	0.00	0	0.00	0.00	0.00
1,4-Dichlorobenzene	50	0.10	0.05	0.10	0.28	0.02
1,2,4-Trichlorobenzene	50	0.00	0	0.00	0.00	0.00
Hexachlorobutadiene	50	0.00	0	0.00	0.00	0.00

The average detection limit varies between 0.5 and 1 $\mu g/m^3$.

Table 11 VOC Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1999.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
Ethane	57	3.50	1.15	3.46	6.74	1.63
Ethylene	57	3.52	1.42	3.36	6.98	1.42
Acetylene	57	2.89	1.64	2.33	8.09	1.02
Propylene	57	1.09	0.47	1.05	2.76	0.46
Propane	57	4.14	1.91	3.85	10.18	1.56
1-Propyne	55	0.14	0.05	0.13	0.32	0.05
Isobutane	57	1.94	1.34	1.52	9.31	0.65
1-Butene/Isobutene	57	0.71	0.27	0.66	1.79	0.33
1,3-Butadiene	57	0.22	0.10	0.20	0.57	0.09
Butane	57	4.21	2.36	3.47	15.71	1.31
trans-2-Butene	57	0.17	0.09	0.16	0.63	0.07
2,2-Dimethylpropane	57	0.05	0.02	0.05	0.11	0.02
1-Butyne	57	0.01	0.02	0.00	0.05	0.00
cis-2-Butene	57	0.16	0.08	0.15	0.53	0.07
Isopentane	57	4.52	2.58	3.99	14.17	1.56
1-Pentene	57	0.18	0.07	0.17	0.42	0.08
2-Methyl-1-butene	57	0.30	0.16	0.27	0.80	0.11
Pentane	57	1.84	0.87	1.70	5.75	0.77
Isoprene	53	0.35	0.43	0.20	2.73	0.08
trans-2-Pentene	57	0.21	0.12	0.19	0.64	0.05
cis-2-Pentene	57	0.19	0.07	0.19	0.43	0.08
2-Methyl-2-butene	57	0.42	0.18	0.40	1.12	0.20
2,2-Dimethylbutane	57	0.30	0.14	0.27	0.85	0.09
Cyclopentene	55	0.08	0.03	0.07	0.18	0.03
4-Methyl-1-pentene	57	0.03	0.03	0.04	0.09	0.00
3-Methyl-1-pentene	57	0.03	0.03	0.04	0.09	0.00
Cyclopentane	57	0.29	0.16	0.25	0.88	0.09
2,3-Dimethylbutane	57	0.40	0.20	0.36	1.04	0.11
trans-4-Methyl-2-pentene	57	0.02	0.06	0.00	0.39	0.00
2-Methylpentane	57	1.57	0.90	1.40	4.81	0.44
cis-4-Methyl-2-pentene	57	0.04	0.05	0.00	0.16	0.00
3-Methylpentane	57	1.04	0.58	0.93	3.45	0.28
1-Hexene	57	0.23	0.08	0.23	0.42	0.00
Hexane	57	0.94	0.48	0.82	2.68	0.28
trans-2-Hexene	57	0.07	0.03	0.06	0.15	0.02
2-Ethyl-1-Butene	57	0.04	0.03	0.04	0.13	0.00
trans-3-Methyl-2-pentene	57	0.05	0.04	0.05	0.17	0.00
cis-2-Hexene	57	0.05	0.04	0.04	0.15	0.00
cis-3-Methyl-2-pentene	57	0.07	0.04	0.07	0.18	0.00
2,2-Dimethylpentane	57	0.06	0.03	0.06	0.20	0.02
Methylcyclopentane	57	0.63	0.31	0.60	1.65	0.20
2,4-Dimethylpentane	57	0.27	0.16	0.24	0.89	0.09
2,2,3-Trimethylbutane	57	0.00	0.01	0.00	0.05	0.00
1-Methylcyclopentene	57	0.10	0.05	0.09	0.26	0.05
Benzene	57	1.09	0.43	1.11	2.34	0.44
Cyclohexane	57	0.22	0.14	0.19	0.92	0.05
2-Methylhexane	57	0.51	0.23	0.46	1.39	0.19
2,3-Dimethylpentane	57	0.60	0.31	0.49	1.72	0.21
Cyclohexene	57	0.03	0.03	0.04	0.08	0.00

Table 11 VOC Concentrations (μg/m³) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1999.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
3-Methylhexane	57	0.60	0.30	0.51	1.96	0.20
1-Heptene	37	0.20	0.10	0.19	0.53	0.06
2,2,4-Trimethylpentane	57	0.76	0.53	0.57	2.82	0.27
trans-3-Heptene	57	0.01	0.01	0.00	0.03	0.00
Heptane	57	0.52	0.26	0.46	1.28	0.17
trans-2-Heptene	57	0.03	0.02	0.04	0.08	0.00
cis-2-Heptene	55	0.03	0.03	0.04	0.11	0.00
2,2-Dimethylhexane	57	0.03	0.01	0.03	0.07	0.00
Methylcyclohexane	57	0.32	0.24	0.23	1.40	0.09
2,5-Dimethylhexane	57	0.10	0.05	0.09	0.26	0.04
2,4-Dimethylhexane	57	0.15	0.06	0.13	0.37	0.07
2,3,4-Trimethylpentane	57	0.23	0.14	0.20	0.77	0.08
Toluene	57	5.86	3.49	5.55	16.59	1.55
2-Methylheptane	57	0.22	0.09	0.20	0.52	0.11
1-Methylcyclohexene	57	0.07	0.02	0.07	0.12	0.03
4-Methylheptane	57	0.09	0.04	0.08	0.20	0.03
3-Methylheptane	57	0.20	0.08	0.18	0.45	0.09
cis-1,3-Dimethylcyclohexane	57	0.09	0.04	0.08	0.25	0.03
trans-1,4-Dimethylcyclohexane	57	0.04	0.02	0.03	0.14	0.01
2,2,5-Trimethylhexane	57	0.05	0.03	0.04	0.14	0.02
1-Octene	37	0.03	0.02	0.04	0.07	0.00
Octane	57	0.19	0.08	0.18	0.47	0.07
trans-1,2-Dimethylcyclohexane	57	0.05	0.03	0.05	0.18	0.00
trans-2-Octene	20	0.02	0.02	0.00	0.07	0.00
cis-1,4/t-1,3-Dimethylcyclohexane	57	0.04	0.02	0.04	0.12	0.02
cis-1,2-Dimethylcyclohexane	55	0.05	0.02	0.04	0.09	0.00
Ethylbenzene	57	0.76	0.36	0.73	2.05	0.26
m and p-Xylene	57	2.61	1.34	2.38	7.32	0.88
Styrene	53	0.55	1.32	0.19	9.24	0.00
o-Xylene	57	0.86	0.43	0.79	2.39	0.32
1-Nonene	37	0.01	0.02	0.00	0.10	0.00
Nonane	57	0.19	0.09	0.17	0.58	0.06
iso-Propylbenzene	57	0.06	0.03	0.05	0.16	0.02
3,6-Dimethyloctane	57	0.03	0.02	0.03	0.08	0.00
n-Propylbenzene	57	0.15	0.08	0.13	0.50	0.03
3-Ethyltoluene	57	0.47	0.30	0.38	1.76	0.04
4-Ethyltoluene	57	0.25	0.15	0.21	0.86	0.03
1,3,5-Trimethylbenzene	57	0.26	0.17	0.20	0.94	0.01
2-Ethyltoluene	57	0.20	0.11	0.17	0.66	0.02
1-Decene	35	0.03	0.04	0.00	0.12	0.00
tert-Butylbenzene	57	0.01	0.02	0.00	0.06	0.00
1,2,4-Trimethylbenzene	57	0.80	0.53	0.62	2.94	0.03
Decane	57	0.26	0.14	0.22	0.90	0.06
iso-Butylbenzene	57	0.03	0.01	0.03	0.06	0.00
sec-Butylbenzene	57	0.03	0.01	0.03	0.06	0.01
1,2,3-Trimethylbenzene	57	0.21	0.12	0.17	0.62	0.01
p-Cymene	57	0.04	0.03	0.04	0.12	0.00
Indane	57	0.11	0.06	0.09	0.30	0.02
1,3-Diethylbenzene	57	0.06	0.03	0.06	0.16	0.00

Table 11 VOC Concentrations (μg/m³) at Station 9119, 65 Ellen Street, Winnipeg from January 1 to December 31, 1999.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
1,4-Diethylbenzene	57	0.18	0.13	0.15	0.72	0.00
n-Butylbenzene	57	0.05	0.03	0.05	0.15	0.00
1,2-Diethylbenzene	57	0.03	0.01	0.03	0.06	0.00
Undecane	57	0.17	0.10	0.15	0.55	0.00
Naphthalene	32	0.30	0.29	0.20	1.32	0.00
Dodecane	57	0.08	0.05	0.08	0.27	0.00
Hexylbenzene	57	0.02	0.03	0.00	0.08	0.00
Freon22	57	0.85	0.79	0.71	6.57	0.42
Chloromethane	57	1.14	0.11	1.11	1.50	0.91
Freon114	57	0.23	0.05	0.25	0.32	0.14
Freon113	55	0.71	0.06	0.70	0.86	0.50
Vinylchloride	57	0.02	0.01	0.03	0.06	0.00
Bromomethane	57	0.15	0.04	0.16	0.20	0.09
Chloroethane	57	0.09	0.03	0.09	0.20	0.04
Freon11	57	1.87	0.35	1.80	3.46	1.55
Freon12	57	2.86	0.26	2.81	3.97	2.33
Ethylbromide	57	0.02	0.02	0.03	0.05	0.00
1,1-Dichloroethylene	57	0.06	0.02	0.07	0.10	0.00
Dichloromethane	57	1.65	1.64	0.95	6.66	0.25
trans-1,2-Dichloroethylene	55	0.03	0.02	0.03	0.05	0.00
1,1-Dichloroethane	57	0.03	0.02	0.04	0.06	0.00
cis-1,2-Dichloroethylene	57	0.03	0.02	0.04	0.06	0.00
Chloroform	57	0.14	0.03	0.14	0.24	0.09
1,2-Dichloroethane	57	0.08	0.01	0.08	0.10	0.05
1,1,1-Trichloroethane	57	0.37	0.03	0.37	0.46	0.29
Carbontetrachloride	57	0.63	0.11	0.66	0.86	0.35
Dibromomethane	57	0.09	0.04	0.10	0.15	0.00
1,2-Dichloropropane	55	0.02	0.02	0.00	0.06	0.00
Bromodichloromethane	37	0.11	0.03	0.11	0.19	0.00
Trichloroethylene	57	0.37	0.26	0.32	1.33	0.05
cis-1,3-Dichloropropene	57	0.00	0.00	0.00	0.00	0.00
trans-1,3-Dichloropropene	55	0.01	0.01	0.00	0.03	0.00
1,1,2-Trichloroethane	57	0.04	0.03	0.05	0.11	0.00
Bromotrichloromethane	6	0.00	0.00	0.00	0.00	0.00
Dibromochloromethane	55	0.06	0.03	0.06	0.11	0.00
EDB	55	0.06	0.03	0.06	0.11	0.00
Tetrachloroethylene	57	0.86	1.03	0.56	5.30	0.13
Benzylchloride	57	0.04	0.01	0.05	0.06	0.02
Chlorobenzene	57	0.00	0.00	0.00	0.00	0.00
Bromoform	57	0.05	0.02	0.05	0.08	0.02
1,4-Dichlorobutane	57	0.00	0.01	0.00	0.04	0.00
1,1,2,2-Tetrachloroethane	57	0.05	0.02	0.05	0.08	0.00
1,3-Dichlorobenzene	57	0.00	0.00	0.00	0.00	0.00
1,4-Dichlorobenzene	57	0.11	0.04	0.10	0.20	0.04
1,2-Dichlorobenzene	57	0.00	0.00	0.00	0.00	0.00
1,2,4-Trichlorobenzene	57	0.00	0.00	0.00	0.00	0.00
Hexachlorobutadiene	57	0.00	0.00	0.00	0.00	0.00

The average detection limit varies between 0.5 and 1 μg/m³.

Table 12 PAH Concentrations (ng/m³) at Station 9119, 65 Ellen Street, Winnipeg from January 1, 1997 to December 31, 1999.

COMPOUNDS	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum Concentration	Minimum Concentration
Acenaphthylene	67	1.667	2.065	0.785	9.804	0.090
Acenaphthene	67	0.910	0.696	0.759	3.941	0.092
Fluorene	67	2.553	2.493	2.095	20.021	0.676
2-Me-Fluorene	67	0.981	0.755	0.726	3.902	0.123
Phenanthrene	67	9.878	17.856	6.381	148.599	1.992
Anthracene	67	0.998	3.964	0.446	32.592	0.114
Fluoranthene	67	2.818	8.528	1.546	71.149	0.523
Pyrene	67	2.241	6.941	1.410	57.924	0.517
Benzo(a)Fluorene	67	0.186	0.837	0.076	6.923	0.018
Benzo(b)Fluorene	67	0.101	0.462	0.039	3.762	0.014
1-Me-Pyrene	67	0.136	0.485	0.062	4.025	0.012
Benzo(g,h,i)Fluoranthene	67	0.308	0.956	0.141	7.924	0.054
Benz(a)Anthracene	67	0.318	1.907	0.062	15.448	0.013
Chrysene	43	0.184	0.139	0.144	0.573	0.045
Triphenylene	43	0.070	0.052	0.048	0.306	0.024
Chrysene&Triphenylene	24	1.085	3.797	0.166	18.736	0.067
7-Me-Benz(a)Anthracene	67	0.000	0.000	0.000	0.000	0.000
Benzo(b)Fluoranthene	43	0.265	0.214	0.202	1.044	0.061
Benzo(k)Fluoranthene	43	0.080	0.064	0.057	0.336	0.023
Benzo(b)&(k)Fluoranthene	24	2.265	9.701	0.233	47.798	0.077
Benzo(e)Pyrene	67	0.345	1.534	0.126	12.582	0.037
Benzo(a)Pyrene	67	0.249	1.361	0.055	10.516	0.010
Perylene	67	0.188	0.414	0.000	1.338	0.008
2-Me-Cholanthrene	67	0.000	0.000	0.000	0.000	0.000
Indeno(1,2,3-cd)Pyrene	67	0.317	1.442	0.109	11.907	0.039
Dibenz(a,c)&(a,h)Anthracene	67	0.204	0.509	0.000	1.560	0.002
Benzo(b)Chrysene	67	0.217	0.375	0.000	0.780	0.022
Benzo(g,h,i)Perylene	67	0.376	1.172	0.172	9.705	0.070
Anthanthrene	67	0.200	0.409	0.000	1.033	0.014

Table 13 PCDD/PCDF Concentrations (pg/m³) at Station 9119, 65 Ellen Street, Winnipeg from April 3, 1995 to December 31, 1999. A total of 57 samples were collected during this five year period, 5 in 1995, 11 in 1996, 15 in 1997, 14 in 1998 and 12 in 1999.

Congener	Mean	Median	St. Dev.	Min	Max	Number of Samples
2378-TCDD	0.00651	0.00000	0.00829	0.00300	0.02529	7
12378-P5CDD	0.01474	0.00600	0.02369	0.00300	0.14626	35
123478-H6CDD	0.01614	0.00000	0.02439	0.00200	0.12771	28
123678-H6CDD	0.02372	0.00843	0.04505	0.00300	0.28240	39
123789-H6CDD	0.04066	0.00998	0.07790	0.00400	0.46322	38
1234678-H7CDD	0.21413	0.09900	0.49186	0.03000	3.64552	56
OCDD	0.70746	0.32873	1.32258	0.10949	8.27397	57
2378-TCDF	0.03523	0.01700	0.07883	0.00326	0.57000	56
12378-P5CDF	0.01266	0.00248	0.02670	0.00200	0.14900	31
23478-P5CDF	0.02405	0.00600	0.08160	0.00300	0.51000	38
123478-H6CDF	0.02927	0.00902	0.06591	0.00300	0.41100	48
123678-H6CDF	0.01607	0.00410	0.02993	0.00200	0.15800	40
234678-H6CDF	0.02506	0.00412	0.05475	0.00300	0.28200	37
123789-H6CDF	0.04853	0.00000	0.09914	0.00300	0.29884	9
1234678-H7CDF	0.04641	0.02200	0.07146	0.00407	0.43792	54
1234789-H7CDF	0.02406	0.00000	0.05008	0.00200	0.24633	24
OCDF	0.04567	0.03000	0.05932	0.00407	0.37089	54
TCDD	0.03851	0.00845	0.07272	0.00300	0.45058	39
P5CDD	0.07444	0.01600	0.16167	0.00400	0.97661	39
H6CDD	0.20528	0.07998	0.43838	0.01262	3.05037	51
H7CDD	0.43198	0.20300	0.92066	0.05495	6.75869	56
OCDD	0.70746	0.32873	1.32258	0.10949	8.27397	57
TOTAL PCDD	1.39281	0.61352	2.72177	0.17706	19.51022	57
TCDF	0.16839	0.08700	0.34814	0.01221	2.51400	55
P5CDF	0.11851	0.04600	0.34164	0.00900	2.52300	55
H6CDF	0.12720	0.05000	0.27850	0.00488	1.73300	53
H7CDF	0.09097	0.04093	0.15013	0.01400	0.98253	52
OCDF	0.04567	0.03000	0.05932	0.00407	0.37089	54
TOTAL PCDF	0.52126	0.26100	1.02177	0.00000	7.32600	57
TEQ	0.042561	0.023306	0.066766	0.007008	0.425942	57

Table 14 Aldehyde/Ketone Concentrations ($\mu g/m^3$) at Station 9119, 65 Ellen Street, Winnipeg from March 11, 1997 to December 31, 1999.

Compounds	Number of Samples	Arithmetic Mean	Standard Deviation	Median	Maximum	Minimum
Formaldehyde	149	2.638	1.157	2.406	9.091	0.437
Acetaldehyde	149	1.409	0.575	1.285	4.167	0.686
Acrolein	149	0.110	0.068	0.091	0.393	0.000
Acetone	149	3.913	1.789	3.574	12.250	1.274
Propionaldehyde	149	0.379	0.158	0.347	0.958	0.116
Crotonaldehyde	149	0.171	0.273	0.071	1.789	0.000
MEK	149	1.322	1.079	1.032	6.530	0.084
Benzaldehyde	149	0.138	0.092	0.125	0.687	0.000
2-Pentanone/Isovaleraldehyde	134	0.138	0.152	0.112	1.171	0.000
Valeraldehyde	149	0.102	0.092	0.083	0.463	0.000
o-Tolualdehyde	149	0.002	0.009	0.000	0.081	0.000
m-Tolualdehyde	149	0.046	0.062	0.000	0.354	0.000
p-Tolualdehyde	149	0.010	0.030	0.000	0.151	0.000
MIBK	149	0.202	0.245	0.123	1.406	0.000
Hexanal	149	0.122	0.164	0.088	1.554	0.000
2,5-Dimethylbenzaldehyde	149	0.000	0.000	0.000	0.000	0.000

DISCUSSION

CAUTIONARY NOTE:

Though it was the intent, within the design of the sampling network, to locate monitoring sites in accord with generally accepted siting criteria and to use collection and analytical procedures that are common to other networks, it should be noted that the data presented in this report may have limitations and, therefore, caution should be exercised towards its use. In particular, when comparing data between Canadian regions and even between stations in the same city, it must be realized that the data represents the condition of the air in the vicinity of the individual monitoring station and may not necessarily reflect community-wide air quality.

A. WINNIPEG AIR QUALITY

Downtown

Air quality in the downtown area of Winnipeg was represented by monitoring at station #9119, 65 Ellen Street, a NAPS Class 1 site. Measurements were made for the parameters carbon monoxide (CO), nitrogen dioxide (NO_2), nitric oxide (NO), nitrogen oxides (NO_x), ground level ozone (O_3), soiling index (coefficient of haze-COH - discontinued in 1999), total suspended particulate (TSP), inhalable particulate (PM_{10}), volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs) and aldehydes/ketones.

Air Quality Index

The Air Quality Index (Figures 6, 7 & 8, Table 15) was in the Good range for over 96% of the time (on average) in 1997, 1998 and 1999 (discounting N/A times). In 1997, there were not any hours where the Air Quality was Poor, whereas in 1998 and 1999 there were 3 and 42 hours, respectively. This Poor Air Quality, in May, 1999, was the result of smoke from forest fires being blown into the City. In 1997 and 1999 the number of Fair hours were similar, 208 and 209 respectively. In 1998, the number of Fair hours was more than double the previous and subsequent year's totals at 468 hours. Sixty percent of these hours occurred in April, 1998 and could be attributed to road dust entrainment by vehicles prior to the annual street cleaning in the spring. The other forty percent occurred in August/September, 1998 and

could be attributed to smoke from the burning of agricultural residues around the city. In all three years the major influencing factor was PM_{10} (averaged over 24 hours) followed by ground-level ozone and then nitrogen dioxide (a distant third).

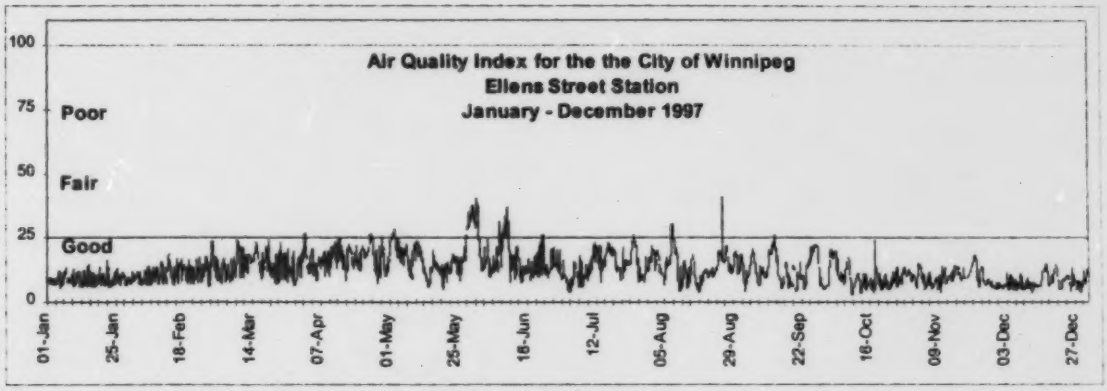

Figure 6. The Air Quality Index for Winnipeg (Downtown) for 1997.

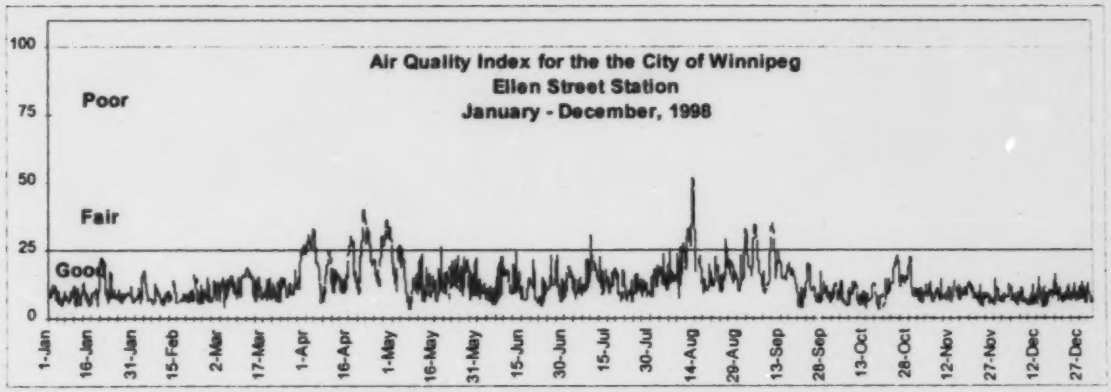

Figure 7. The Air Quality Index for Winnipeg (Downtown) for 1998.

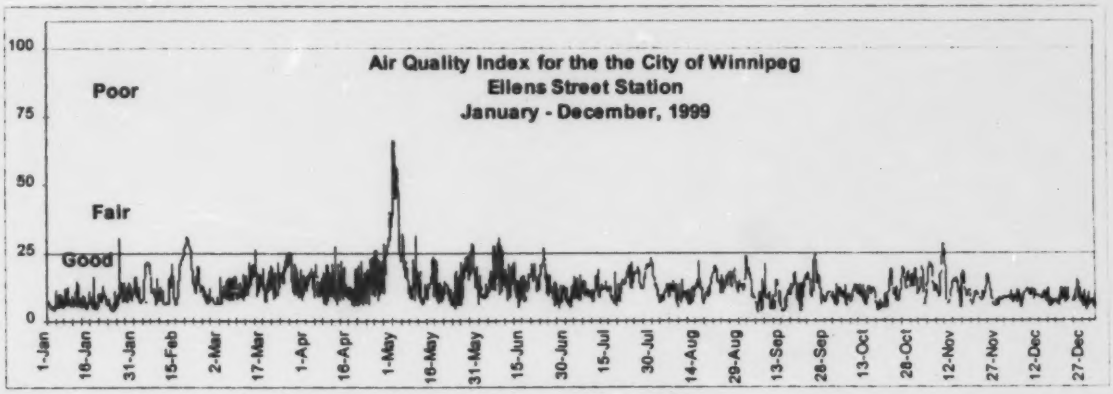

Figure 8. The Air Quality Index for Winnipeg (Downtown) for 1999.

Table 15: Summary of AQI for Winnipeg (Downtown) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

	Number of Hours					
1997	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	% of available
Good	2068	1891	2093	2110	8162	97.5%
Fair	0	187	21	0	208	2.5%
Poor	0	0	0	0	0	0%
V.Poor	0	0	0	0	0	0%
N/A	92	106	94	98	390	--
Total	2160	2184	2208	2208	8760	100.0%
CO	0	0	0	0	0	0.0%
8-Hr CO	0	0	0	9	9	0.1%
COH	0	0	3	0	3	0.0%
24-Hr COH	0	0	0	0	0	0.0%
24-Hr PM_{10}	504	957	1702	1282	4445	50.7%
NO_2	474	47	26	212	759	8.7%
O_3	1090	1074	383	607	3154	36.0%
N/A	92	106	94	98	390	4.5%
Total	2160	2184	2208	2208	8760	100.0%

1998	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	2046	1804	1900	2107	7857	94.3%
Fair	15	281	172	0	468	5.6%
Poor	0	0	3	0	3	0.1%
V.Poor	0	0	0	0	0	0%
N/A	99	99	133	101	432	--
Total	2160	2184	2208	2208	8760	100%
CO	0	0	0	0	0	0.0%
8-Hr CO	0	0	0	9	9	0.1%
COH	0	0	5	1	6	0.1%
24-Hr COH	4	0	0	0	4	0.1%
24-Hr PM_{10}	964	1239	1504	1112	4819	55.0%
NO_2	363	29	18	373	783	8.9%
O_3	730	817	548	612	2707	30.9%
N/A	99	99	133	101	432	4.9%
Total	2184	2184	2208	2208	8784	100%

N/A The AQI would not be available 4% of the time or 1 in every 24 hours due to the internal calibrations that occur each day at 3 a.m. CST. Additional N/A times would occur during routine instrument maintenance, instrument failure and/or repair.

Table 15: Summary of AQI for Winnipeg (Downtown) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

1999	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	2009	1896	2106	2074	8085	97.0%
Fair	59	138	0	12	209	2.5%
Poor	0	42	0	0	42	0.5%
V.Poor	0	0	0	0	0	0.0%
N/A	92	108	102	122	424	--
Total	2160	2184	2208	2208	8760	100.0%
CO	0	0	0	0	0	0.0%
8-Hr CO	2	0	0	11	13	0.1%
COH	1	1	0	0	2	0.0%
24-Hr COH	0	0	0	0	0	0.0%
24-Hr PM_{10}	1031	775	1567	1494	4867	55.7%
NO_2	570	104	13	206	893	10.2%
O_3	464	1196	526	375	2561	29.2%
N/A	92	108	102	122	424	4.8%
Total	2184	2184	2208	2208	8784	100.1%

N/A The AQI would not be available 4% of the time or 1 in every 24 hours due to the internal calibrations that occur each day at 3 a.m. CST. Additional N/A times would occur during routine instrument maintenance, instrument failure and/or repair.

Carbon Monoxide

The maximum 1-hour and the maximum 8-hour concentrations since 1978 have not exceeded the MAL. Average monthly levels of CO in the downtown area (shown in Figures 10 to 12) were slightly higher than those observed in the residential area. Yearly trends are shown in Figure 9.

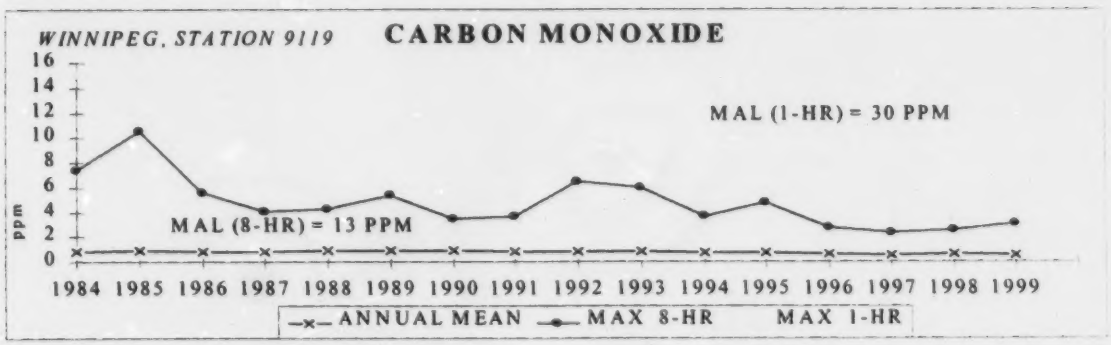

Figure 9 Annual mean, 8-Hr and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg downtown monitoring site.

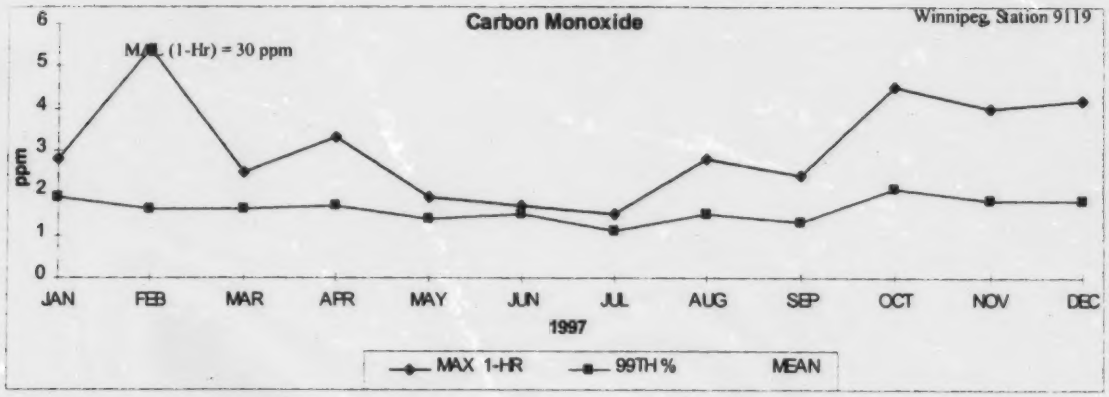

Figure 10 Monthly mean and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg downtown monitoring site for 1997.

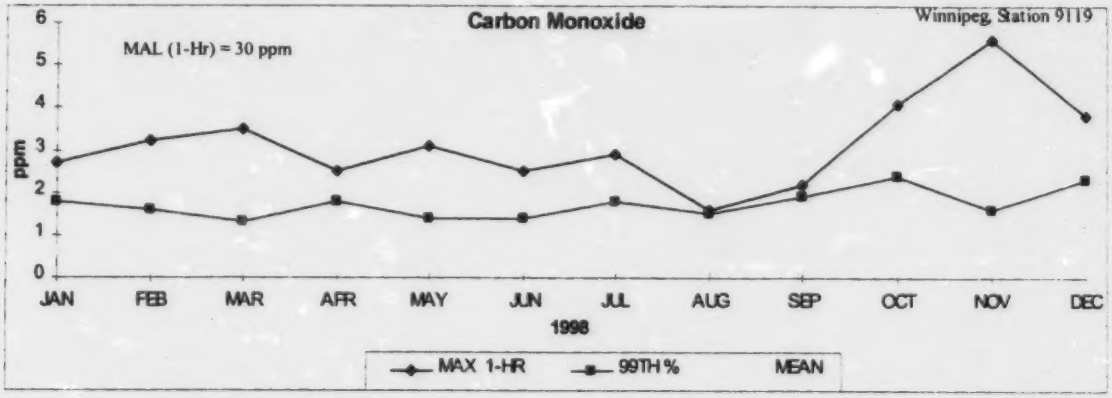

Figure 11 Monthly mean and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg downtown monitoring site for 1998.

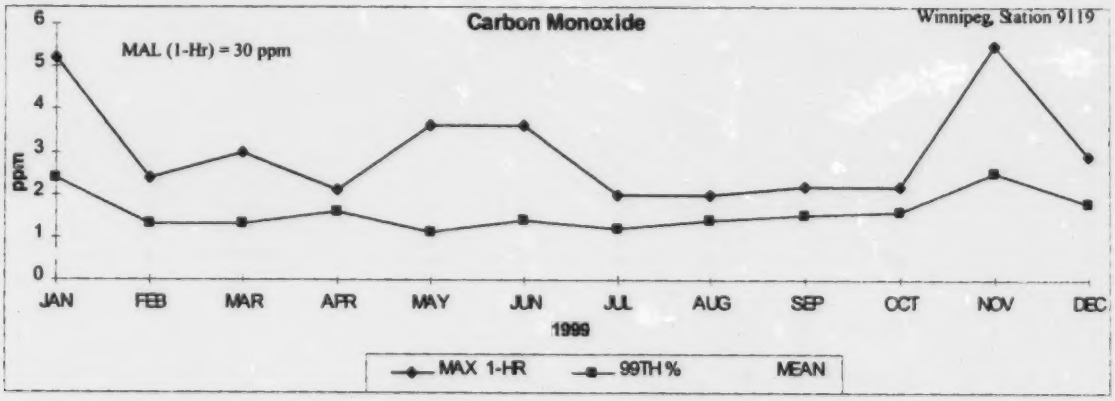

Figure 12 Monthly mean and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg downtown monitoring site for 1999.

Ozone

Ground level O_3 at the downtown station had the lowest annual mean, for 1997, 1998 and 1999, of the three stations monitoring ozone in Manitoba. The annual and monthly trends are shown in Figure 13 and Figures 14, 15 and 16, respectively. The 1-hour MAL of 8.2 pphm has not been exceeded since 1990.

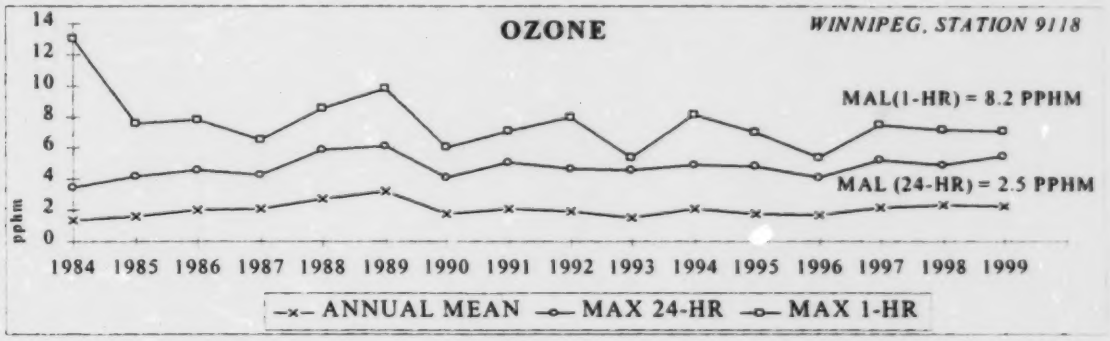

Figure 13 Annual mean, 24-Hr and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg downtown monitoring site.

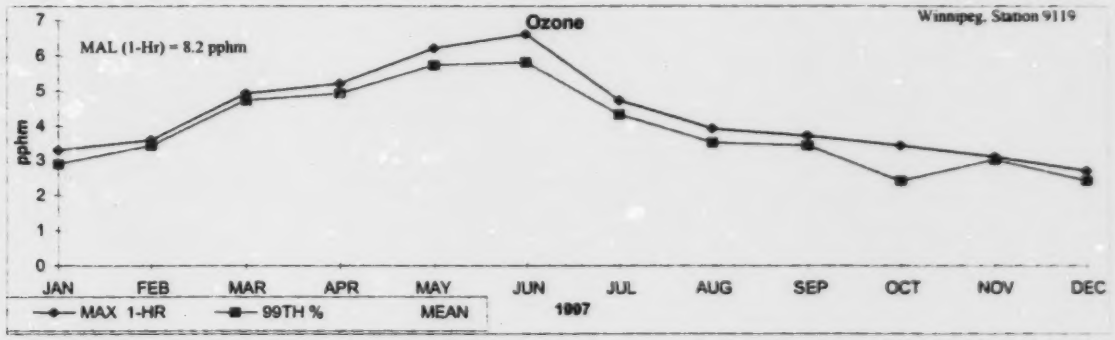

Figure 14 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg downtown monitoring site for 1997.

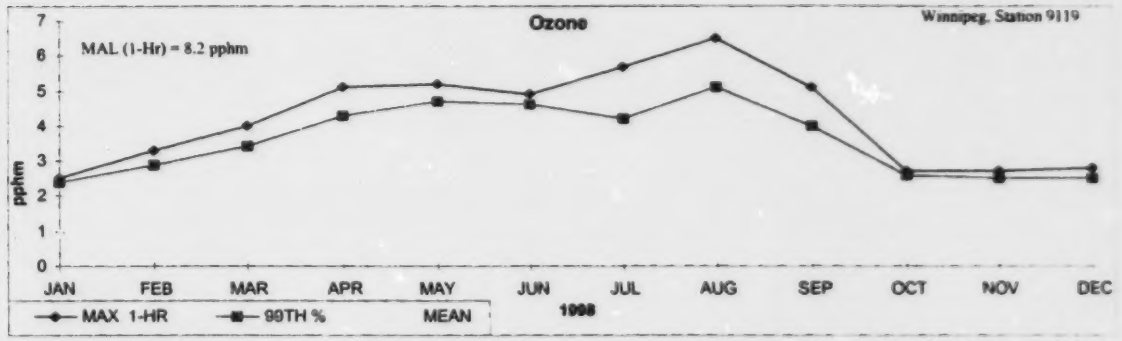

Figure 15 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg downtown monitoring site for 1998.

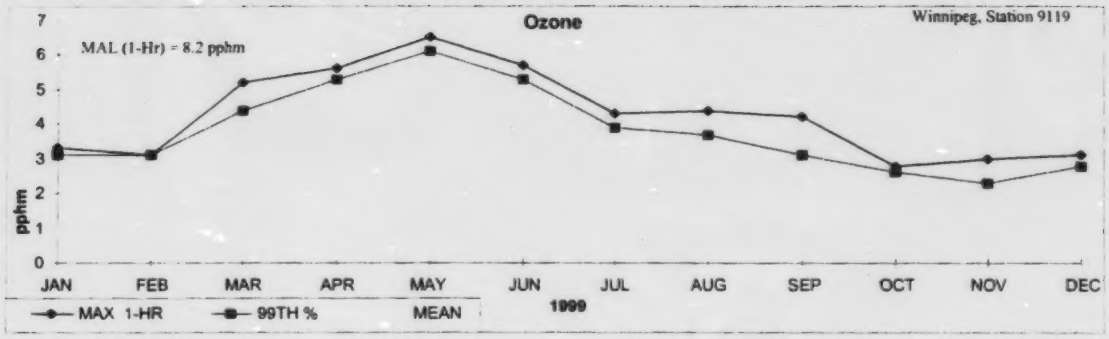

Figure 16 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg downtown monitoring site for 1999.

Nitrogen Dioxide

NO_2 levels in downtown Winnipeg continued to be well below the Manitoba Air Quality Objectives, as in previous years. Average monthly values, for 1997, 1998 and 1999 respectively, are shown in Figures 18 to 20 and were slightly higher than at the residential location. Yearly trends are shown in Figure 17.

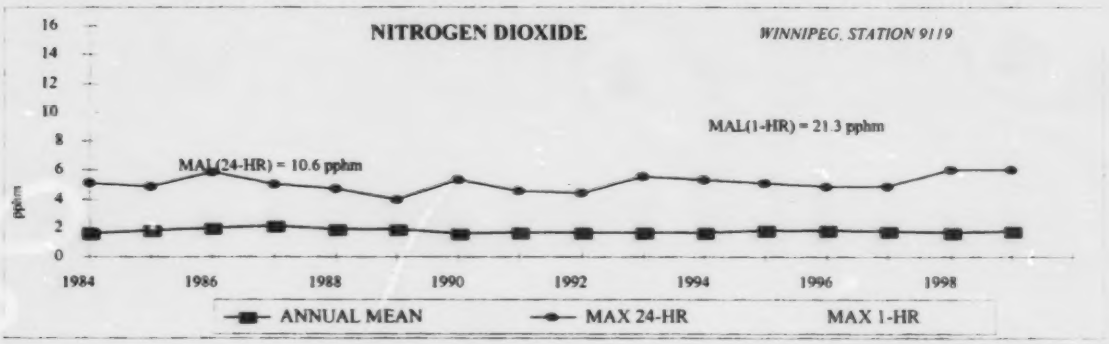

Figure 17 Annual mean, 24-Hr and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg downtown monitoring site.

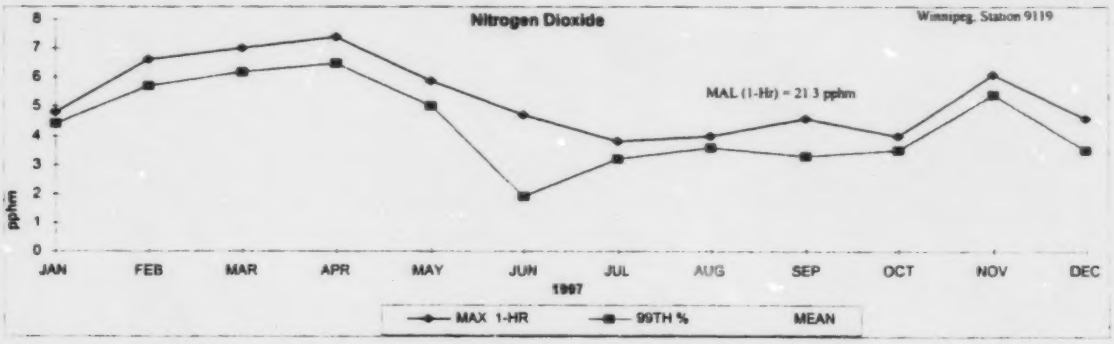

Figure 18 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg downtown monitoring site for 1997.

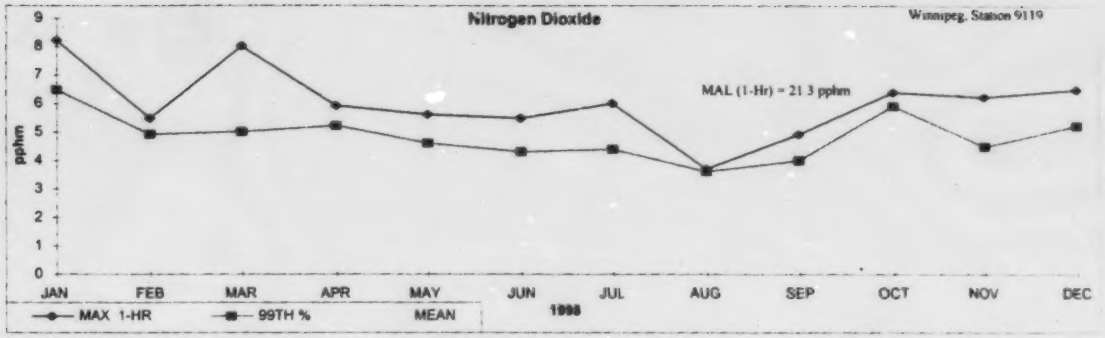

Figure 19 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg downtown monitoring site for 1998.

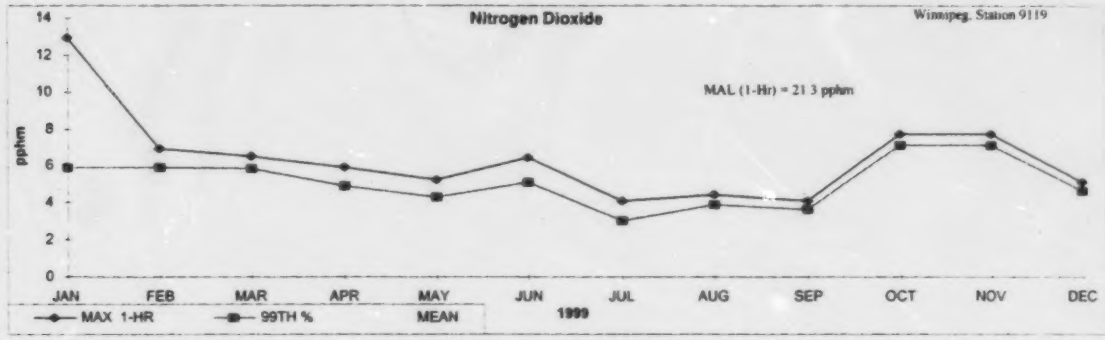

Figure 20 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg downtown monitoring site for 1999.

Nitric Oxide and Nitrogen Oxides

NO and NO_x annual data statistics are summarized in Tables 3, 5 and 7. Manitoba has no Air Quality Objectives or Guidelines for either NO or NO_x.

Soiling Index

Soiling index values were measured as coefficient of haze (COH) units per 1000 feet for a 1-hour sampling period. The monthly means at the downtown site were generally higher than those found at the residential site. Monthly data values are shown in Figures 21 to 23. No exceedences of the 24-hour MAL were observed in 1997, 1998 or 1999. The measurement of the Soiling Index was discontinued in August 1999.

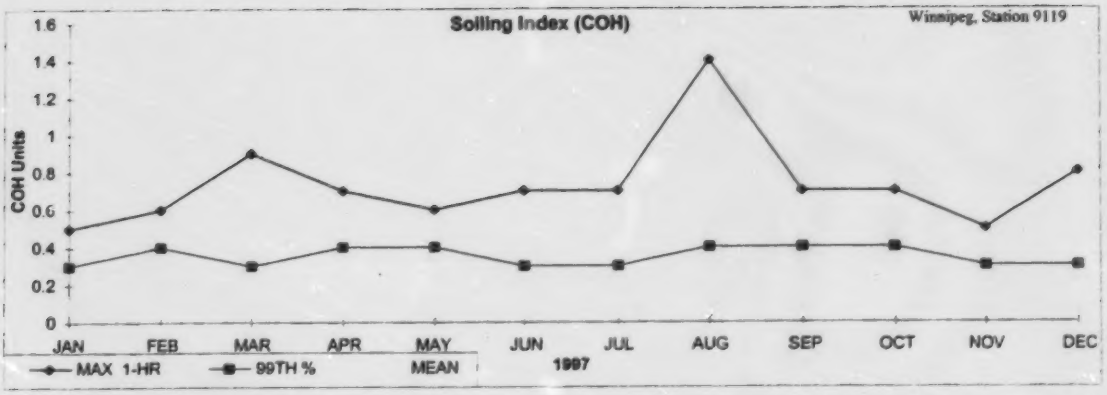

Figure 21 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg downtown monitoring site for 1997.

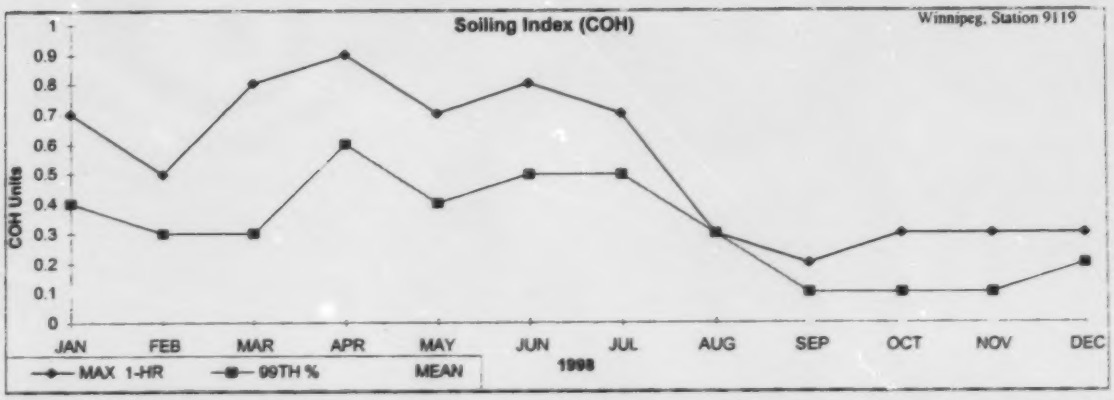

Figure 22 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg downtown monitoring site for 1998.

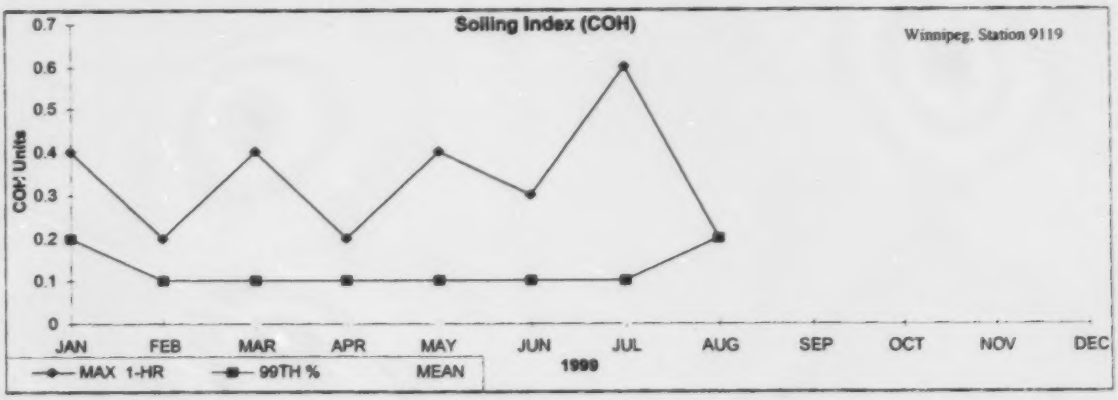

Figure 23 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg downtown monitoring site for 1999.

Total Suspended Particulate (TSP)

TSP samples, collected four days out of every six day rotation, at the downtown monitoring station numbered 225 (61.6% of the year) for 1997, 220 (60.3%) for 1998 and 224 (61.4%) for 1999.

The annual geometric mean for TSP in downtown Winnipeg was higher than at the Winnipeg residential and Brandon sites. Yearly trends are shown in Figure 24 and monthly values are shown in Figures 25, 26 and 27 for 1997, 1998 and 1999, respectively. The 24-hour MAL of 120 $\mu g/m^3$ was exceeded by seven samples in 1997, ten samples in 1998 and eleven samples in 1999 (Figure 28). The maximum 24-hour values and the number of samples above the 24-hour MAL have decreased from 1991. TSP levels arose primarily from prairie dust storms and vehicle-raised dust on city streets.

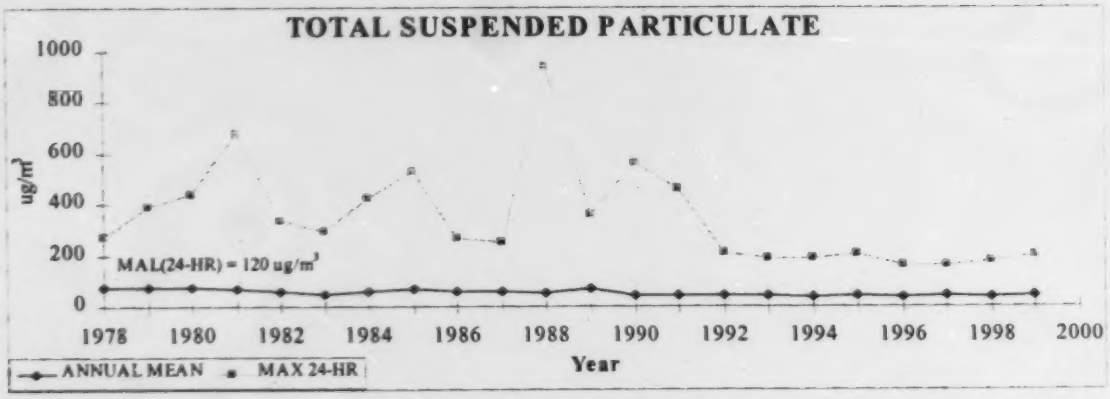

Figure 24 Annual mean and 24-Hr maximum TSP levels calculated and observed for the Winnipeg downtown monitoring site for the period 1978 through 1999.

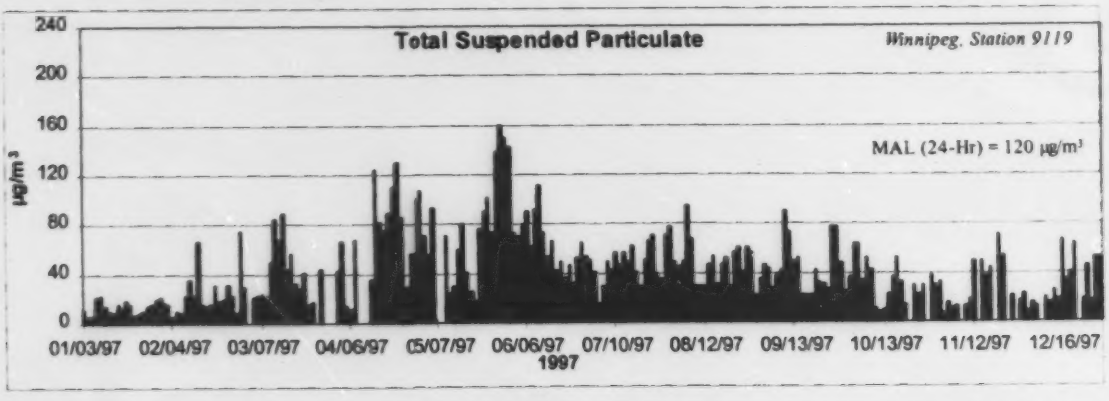

Figure 25 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg downtown monitoring site for 1997.

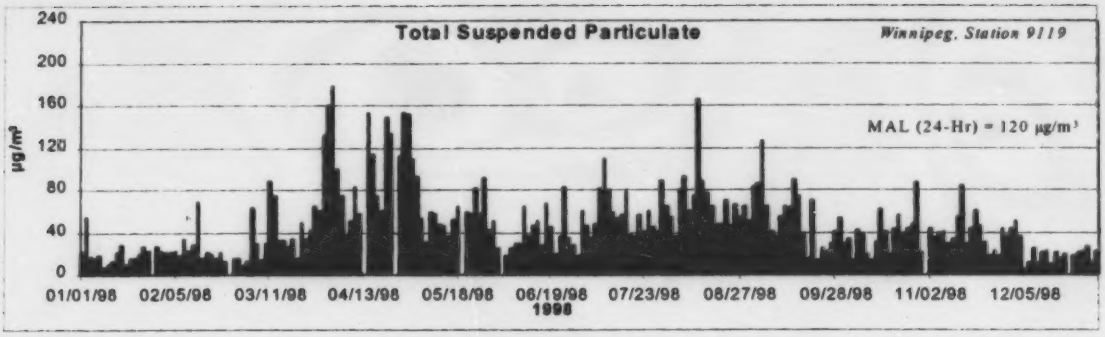

Figure 26 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg downtown monitoring site for 1998.

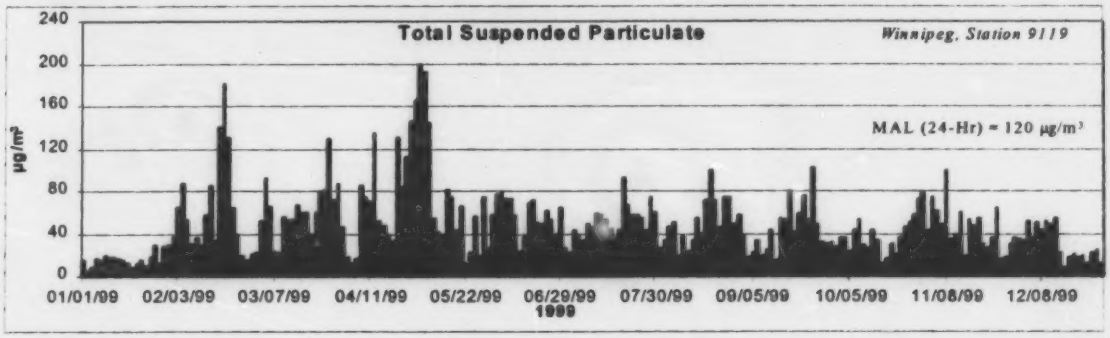

Figure 27 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg downtown monitoring site for 1999.

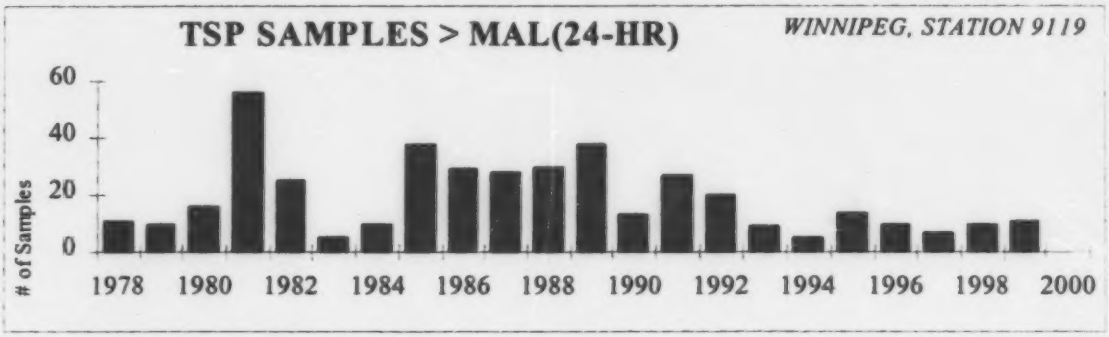

Figure 28 Number of exceedences of the 24-hour MAL (120 µg/m³) observed for the Winnipeg downtown monitoring site for the period 1978 through 1999 on an annual basis.

Inhalable Particulates (PM_{10})

PM_{10} levels were monitored at the downtown station using both a dichotomous sampler (sampling once every six days) and a real-time TEOM sampler. The monthly dichotomous values are shown in Figures 29, 30 and 31 for 1997, 1998 and 1999, respectively. The relative proportion of fine to coarse inhalable particulate is shown graphically and the annual mean fine/coarse ratio was 0.32 in 1997, 0.39 in 1998 and

0.36 in 1999. The daily average PM_{10} level as determined by the TEOM unit are shown in figures 32a, 33a and 34a for 1997, 1998 and 1999, respectively. Yearly statistical results from both the dichotomous (once every sixth day sampling) and real-time (continuous) samplers are shown in Tables 4a, 6a and 8a for 1997, 1998 and 1999, respectively. Objectives or Guidelines for this parameter have not been established.

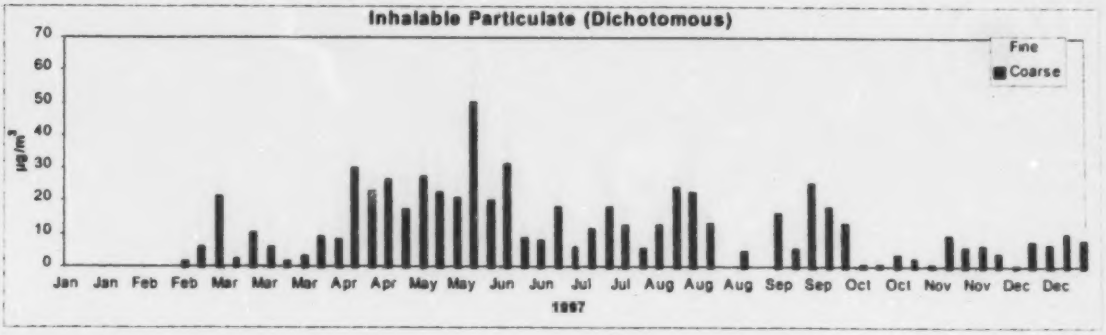

Figure 29 Inhalable particulate levels (fine [< 2.5 µm in diameter] plus coarse [2.5 µm to 10 µm in diameter) by sample date (per 24-Hr sample) for 1997

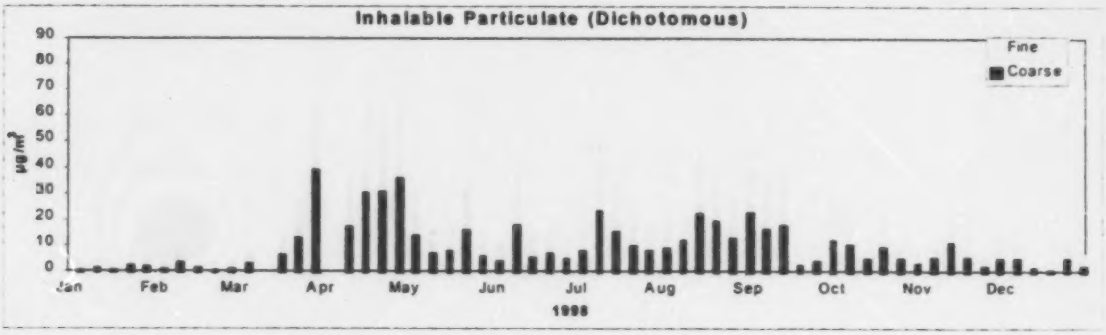

Figure 30 Inhalable particulate levels (fine [< 2.5 µm in diameter] plus coarse [2.5 µm to 10 µm in diameter) by sample date (per 24-Hr sample) for 1998.

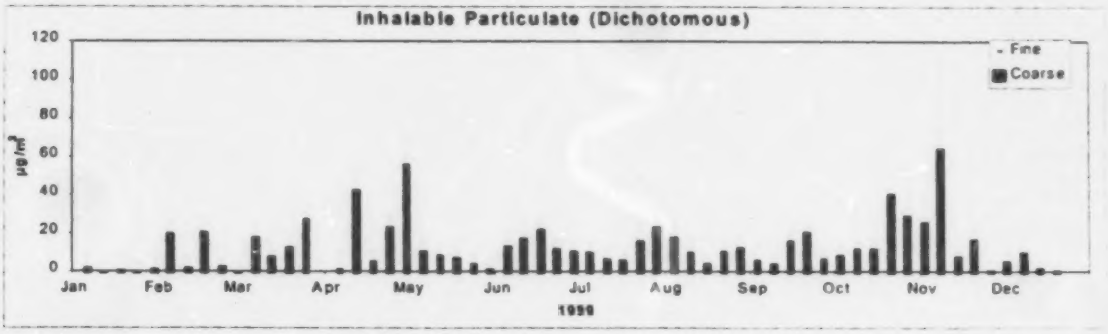

Figure 31 Inhalable particulate levels (fine [< 2.5 µm in diameter] plus coarse [2.5 µm to 10 µm in diameter) by sample date (per 24-Hr sample) for 1999.

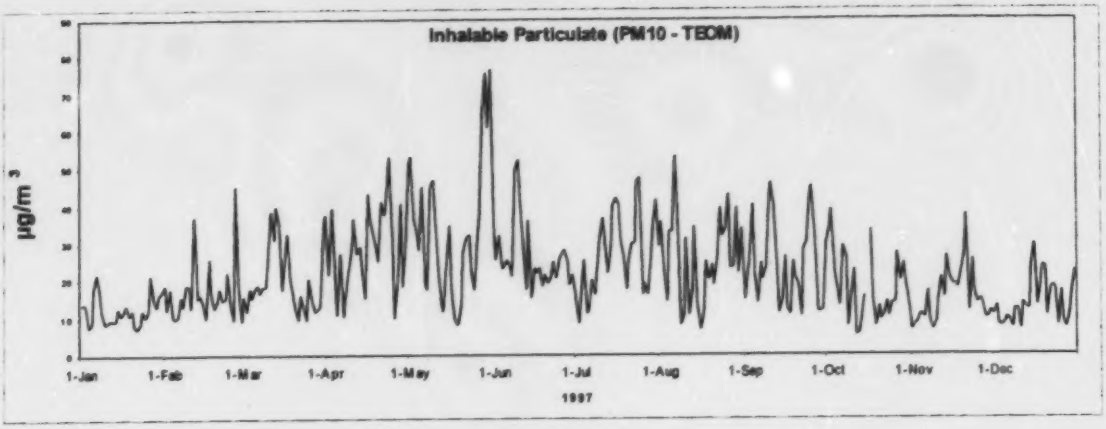

Figure 32a Inhalable particulate levels - PM_{10}: daily averages for 1997.

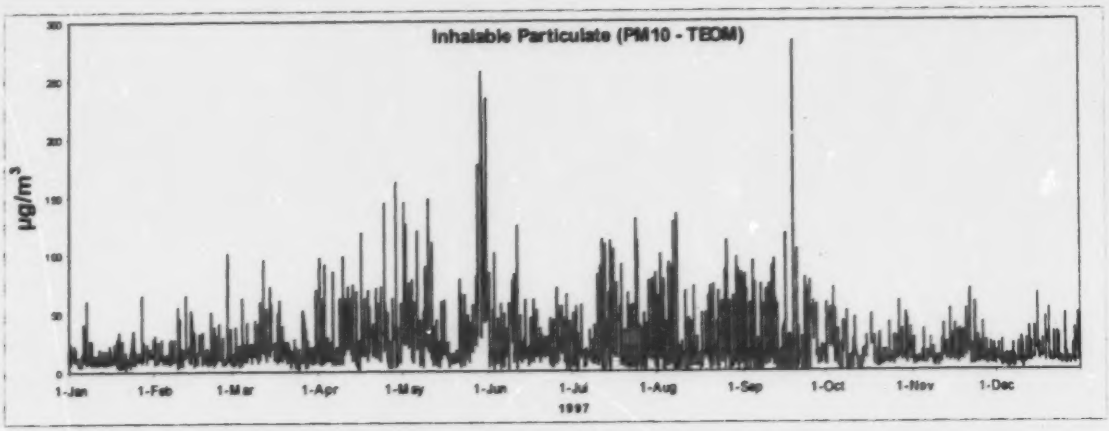

Figure 32b Inhalable particulate levels - PM_{10}: hourly averages for 1997.

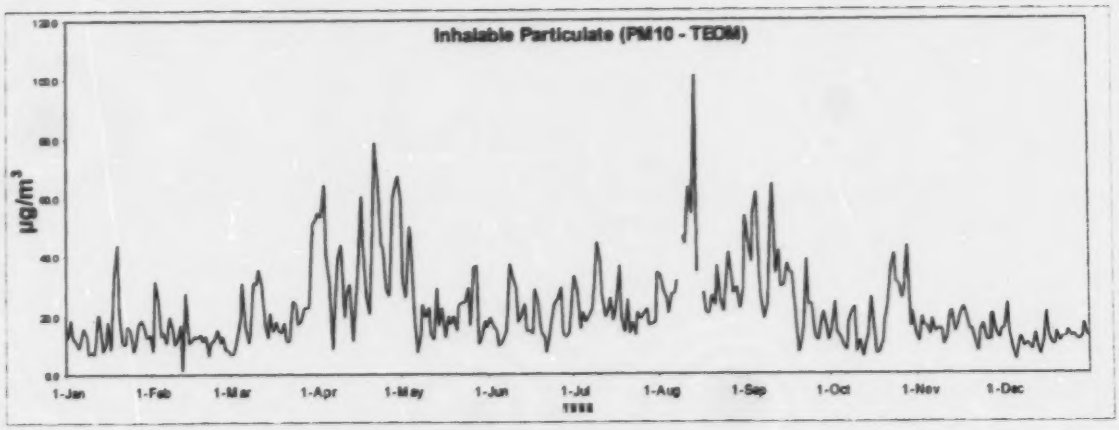

Figure 33a Inhalable particulate levels - PM_{10}: daily averages for 1998.

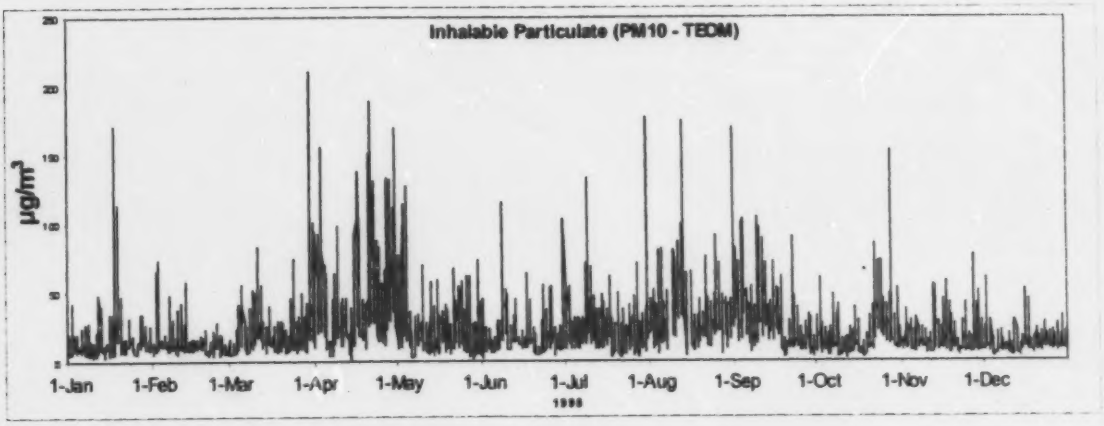

Figure 33b Inhalable particulate levels - PM_{10}: hourly averages for 1998.

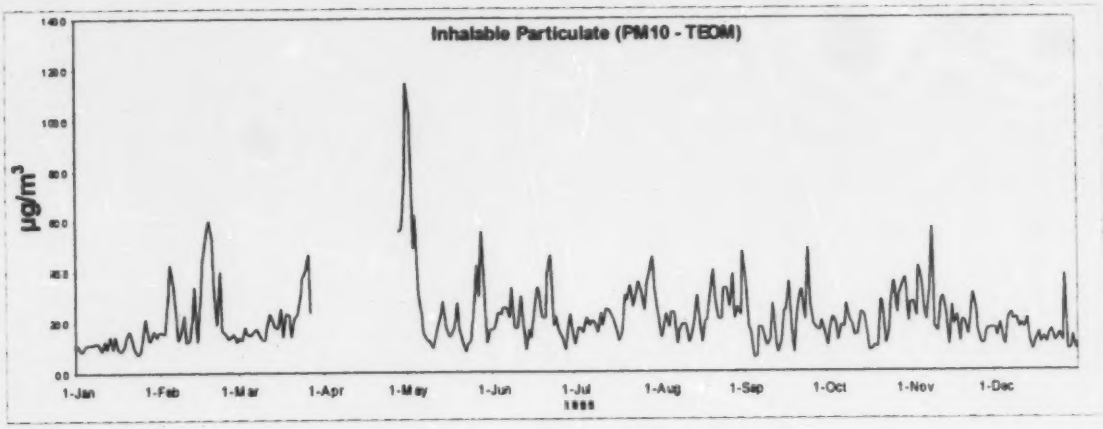

Figure 34a Inhalable particulate levels - PM_{10}: daily averages for 1999.

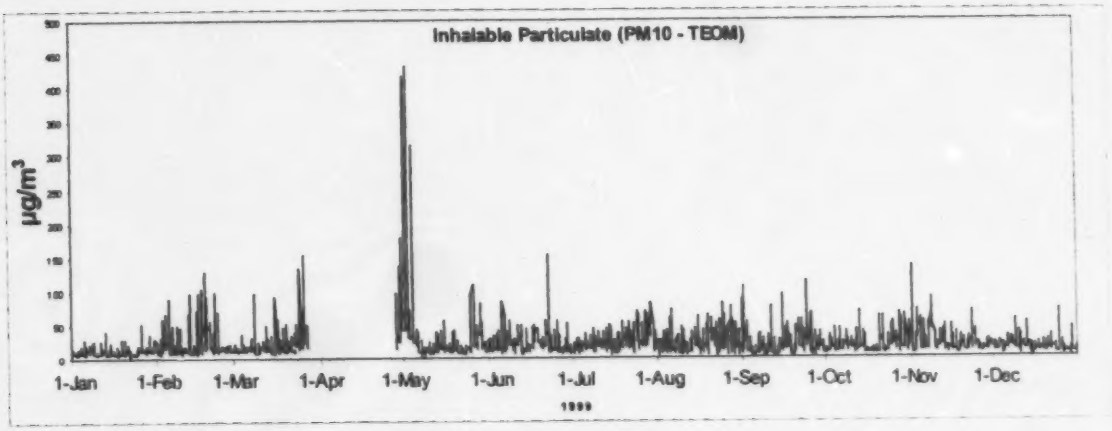

Figure 34b Inhalable particulate levels - PM_{10}: houly averages for 1999.

Volatile Organic Compounds (VOCs)

VOC monitoring results for 150 compounds are shown in Tables 9, 10 and 11 for 1997, 1998 and 1999, respectively. Manitoba does not have Objectives or Guidelines for VOCs but Ontario has promulgated standards for some, none of which were exceeded at this station. Benzene, a carcinogen, had a mean level of 1.48, 1.41 and 1.09 ug/m^3 in 1997, 1998 and 1999, respectively. The value for 1997 was higher than the previous two years while the value for 1999 was the lowest average observed for the 1990's.

Polyaromatic Hydrocarbons (PAHs)

PAH monitoring (Table 12) found that of the 29 compounds screened for, 23 were detected in all of the 67 samples collected between 1 January 1997 and 31 December 1999. Four compounds were present in 43 of the 67 samples, and the remaining 2 compounds were present in 24 samples. Of the 29 compounds listed, only one, Benzo(a)pyrene, has a Guideline limit (Ontario) of 1.1 ng/m^3 for a 24-hr period and 0.3 ng/m^3 for an annual mean. In 1997, both the 24-Hr and the annual guideline limits were exceeded as a result of a high event on September 19th. On this particular day PAH levels were 20-1000 times above normal levels. For 1998 and 1999, both the maximum 24-hr concentration and the annual means observed at the downtown station are well below Ontario's Guidelines. Manitoba does not have Guidelines or Objectives for any of the other 29 compounds in Table 12, Quebec is the only other jurisdiction in Canada that has Air Quality Criteria for some of these PAHs.

Polychlorinated Dibenzo-p-dioxins and Dibenzo-p-furans (PCDDs & PCDFs)

On April 3, 1995 the first sample to be analyzed for dioxins and furans was collected. In the previous report the results for the first three samples collected were presented. Table 13 of the current report lists the summary results of the 57 samples collected from April 3, 1995 to the end of 1999.

In addition to being part of the chemistry of fire in nature these compounds also occur as manufacturing impurities in a number of commercially important chemicals. It is this source that is of greatest concern as the levels of the PCDDs and PCDFs are often much higher than would be encountered in nature. There are seventy-five possible chlorinated species ranging from 2 monochloro isomers to 22 tetrachloro

isomers to 1 octochloro isomer. The tetrachloro isomer 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the most toxic of all the isomers.

Ontario has a 24-hour criteria of 5 pgTEQ/m^3 for chlorinated dibenzo-p-dioxins. A TEQ is a PCDD isomer's toxicity equivalence to 2,3,7,8-TCDD.

The five year mean, for the total PCDD/PCDF concentration was 1.9 pg/m^3 and for TEQ was 0.04 TEQ pg/m^3. On September 19th, 1997 the total PCDD and PCDF concentrations measured were 19.51 pg/m^3 and 1.25 pg/m^3; this translates to a TEQ of 0.2578 pg/m^3. On January 17th, 1998 the maximum TEQ of 0.4259 pg TEQ/m^3 was observed with total PCDDs and PCDFs of 0.391 pg/m^3 and 7.326 pg/m^3. Except for the above two instances the sample day TEQs were on average 1/100th the Ontario criteria.

Aldehydes and Ketones (Carbonyls)

Aldehydes and ketones are hydrocarbon compounds that contain a double-bonded oxygen atom at the end of the carbon chain in the case of the aldehydes or in the interior of the chain in the case of the ketones. Acetone and propionaldehyde are both three carbon chains, one with the double-bonded oxygen on carbon number 2 of the chain and the other on carbon number 1. These compounds are often used as solvents or reagents in the manufacture of other chemicals. Some are by-products of incomplete combustion (the tolualdehydes). Besides being flammable and a fire hazard, a number are also known carcinogens and/or mutagens.

In 1997, on March 11 the NAPS Program began sampling for carbonyl compounds (13 aldehydes and 3 ketones) in ambient air. Table 14 lists the compounds sampled for, along with the three year average value and the maximum value observed in a 24-hour sample. Of these sixteen compounds Ontario has ambient criteria for 6 of these compounds, five of which are 24-hour criteria and the sixth is a 1-hour criteria. Quebec has annual average air quality criteria for the following six compounds: formaldehyde (0.08 µg/m^3), acetaldehyde (0.5 µg/m^3), acrolein (0.2 µg/m^3), acetone (180 µg/m^3), MEK (820 µg/m^3), and benzaldehyde (200 µg/m^3). In Winnipeg, the determined concentrations for the compounds were all well below the criterion.

Residential

The description of Winnipeg residential air quality is based on sampling conducted at station #9118 (299 Scotia Street), a NAPS Class 1 site. The parameters measured at this site were: CO, NO_2, NO, NO_x, O_3, COH, $PM_{10/2.5}$ (the R&P TEOM instrument was changed from a PM_{10} instrument to a $PM_{2.5}$ instrument in early September of 1997), and TSP.

Carbon Monoxide

The annual mean level of CO has not varied much over the last twenty years. Yearly trends are shown in Figure 35 and monthly values in Figures 36, 37 and 38. The average levels were lower than at the Winnipeg downtown station and there were no excursions above the Provincial Criteria in 1997, 1998 and 1999.

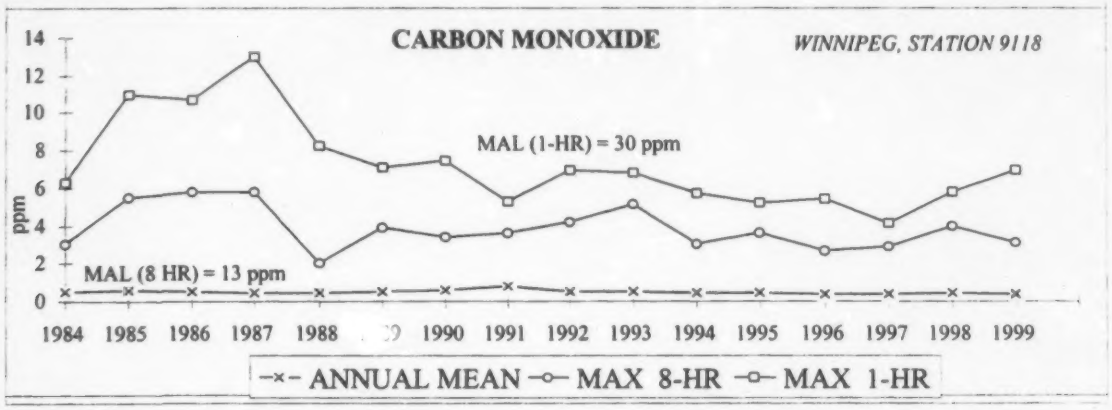

Figure 35 Annual mean, 8-Hr and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg residential monitoring site 1976 - 1999.

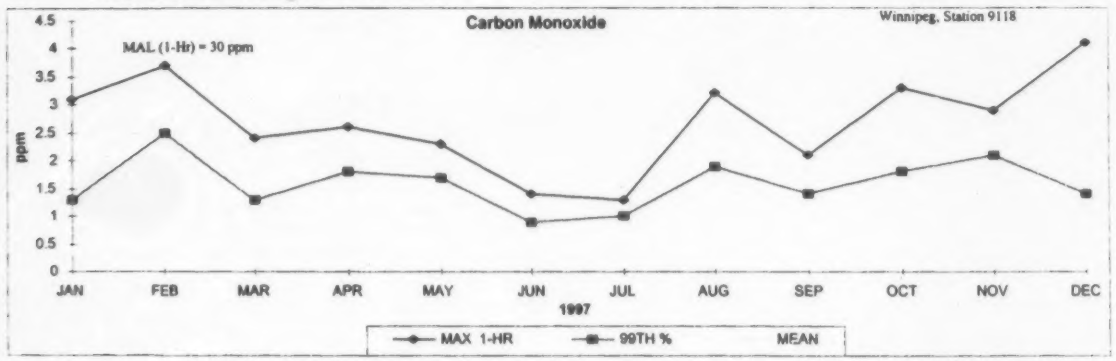

Figure 36 Monthly mean, 8-Hr and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg residential monitoring site for 1997.

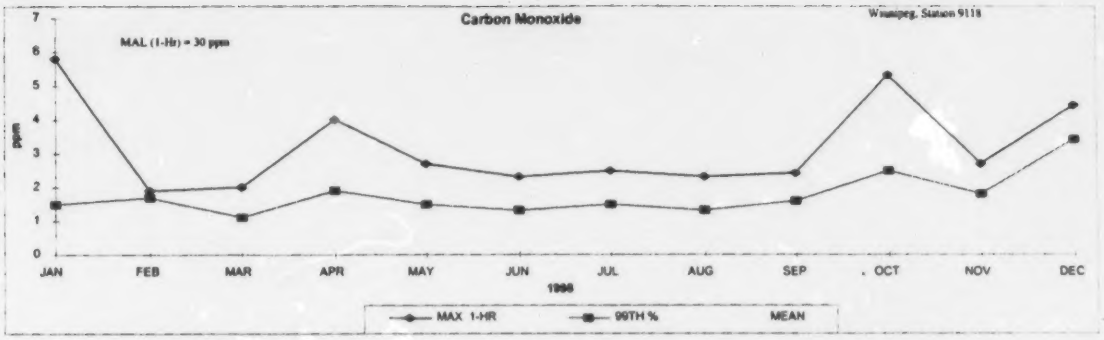

Figure 37 Monthly mean, 8-Hr and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg residential monitoring site for 1998.

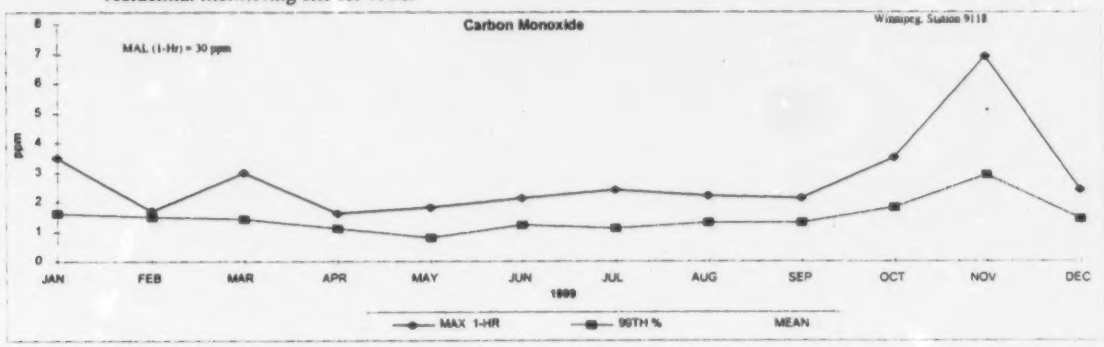

Figure 38 Monthly mean, 8-Hr and 1-Hr maximum carbon monoxide levels calculated and observed for the Winnipeg residential monitoring site for 1999.

Ozone

Ground level O_3 at the residential station had the second lowest annual means, for 1997, 1998 and 1999 of the three stations that monitored ozone in Manitoba. Annual trends are shown in Figure 39. Monthly levels are shown in Figures 40, 41 and 42. The 1-hour MAL of 8.2 pphm has not been exceeded since 1989.

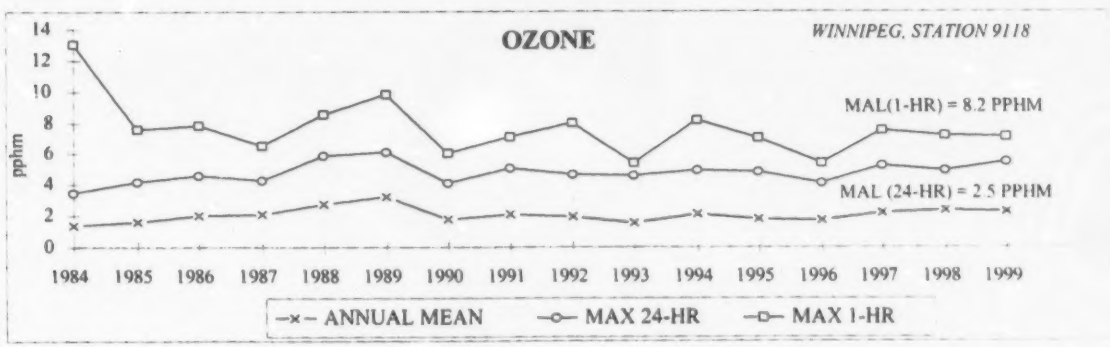

Figure 39 Annual mean, 24-Hr and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg residential monitoring site.

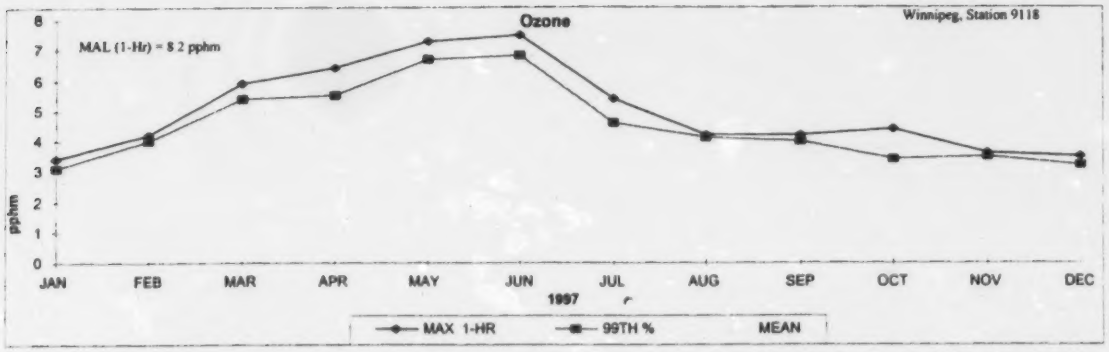

Figure 40 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg residential monitoring site for 1997.

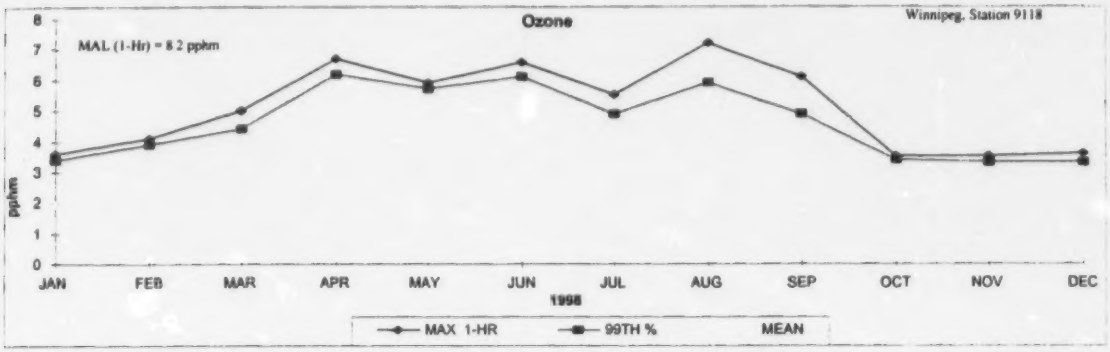

Figure 41 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg residential monitoring site for 1998.

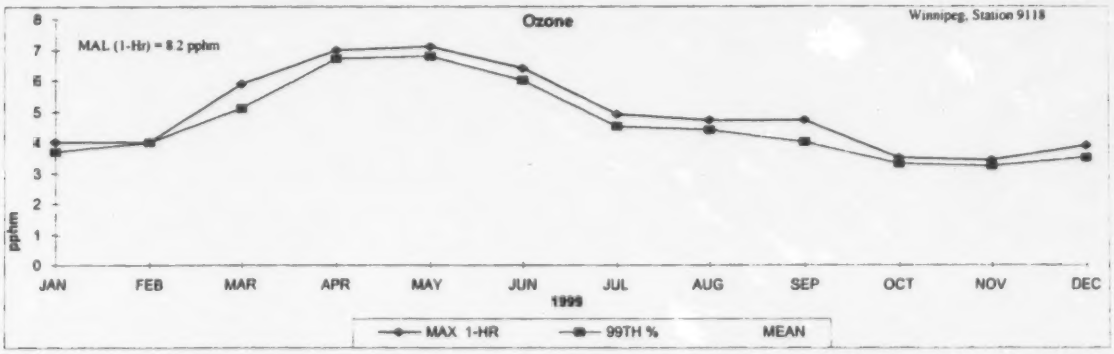

Figure 42 Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Winnipeg residential monitoring site for 1999.

Nitrogen Dioxide

NO_2 levels were generally lower than those measured downtown. Yearly trends are shown in Figure 43 and monthly values are depicted in Figures 44 to 46. Annual mean levels were similar to those found in previous years. All recorded levels were below the Ambient Air Quality Criteria.

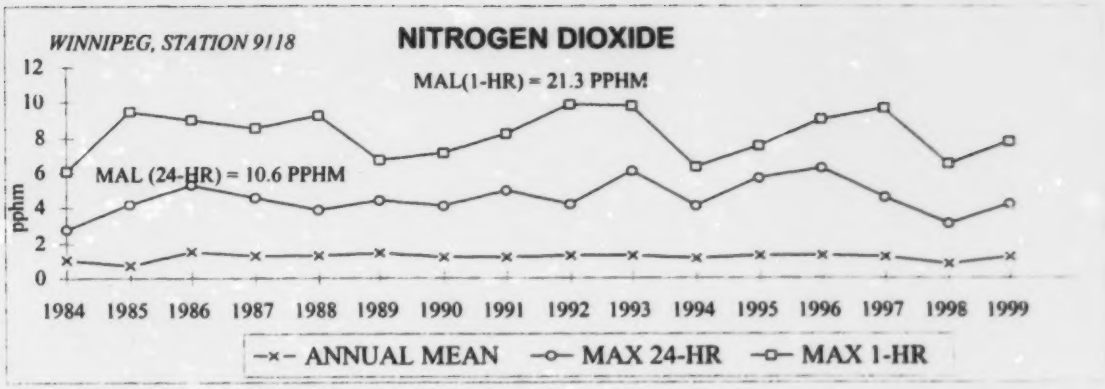

Figure 43 Annual mean, 24-Hr and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg residential monitoring site.

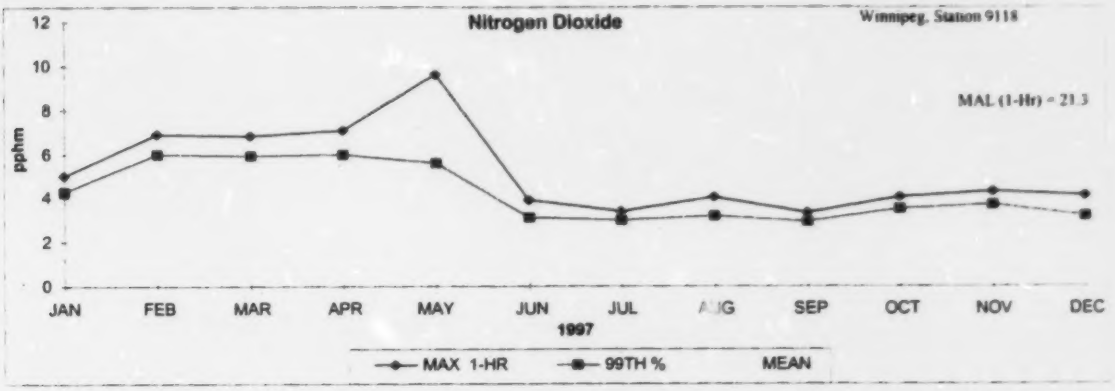

Figure 44 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg residential monitoring site for 1997.

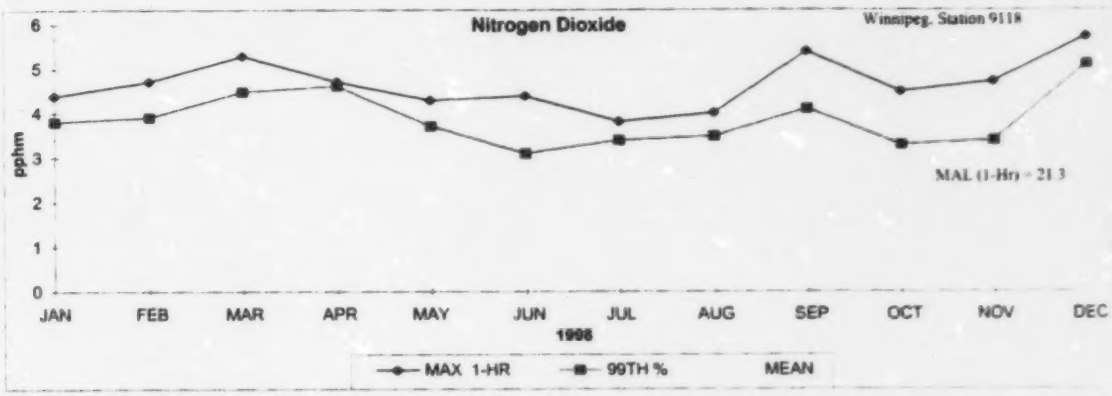

Figure 45 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg residential monitoring site for 1998.

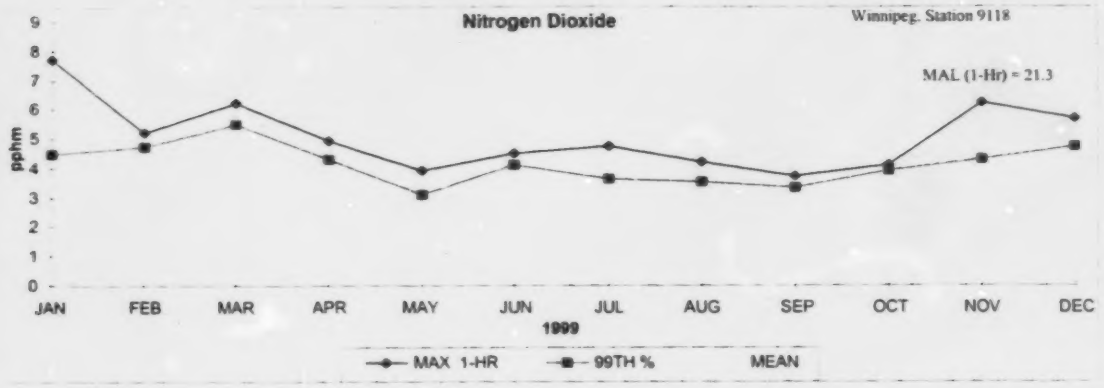

Figure 46 Monthly mean and 1-Hr maximum nitrogen dioxide levels calculated and observed for the Winnipeg residential monitoring site for 1999.

Nitric Oxide and Nitrogen Oxides

NO and NO_x yearly statistical results are shown in Tables 3 and 5. Ambient Air Quality Criteria for NO or NO_x have not been established.

Soiling Index

COH values at site #9118 (Figures 50-52) were generally lower than those found at the downtown site during 1997, 1998 and 1999. No excursions above the 24-hour MAL were observed. Measurement of the Soiling Index was discontinued in July 1999.

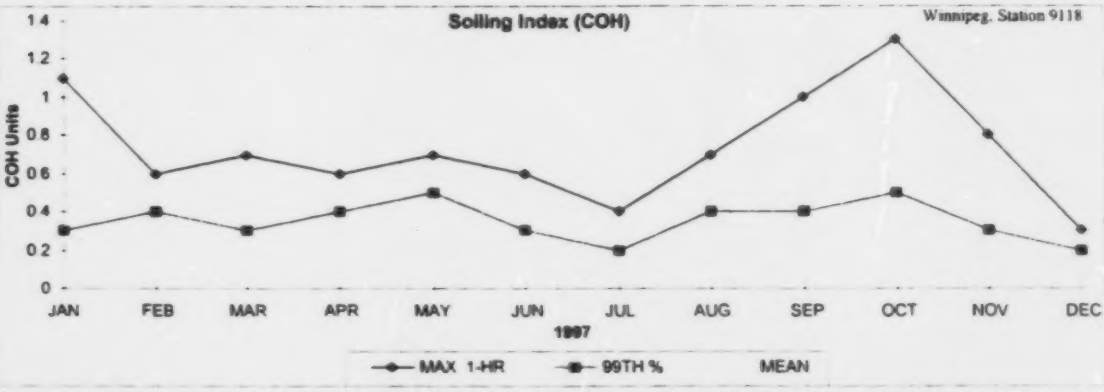

Figure 47 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg residential monitoring site for 1997.

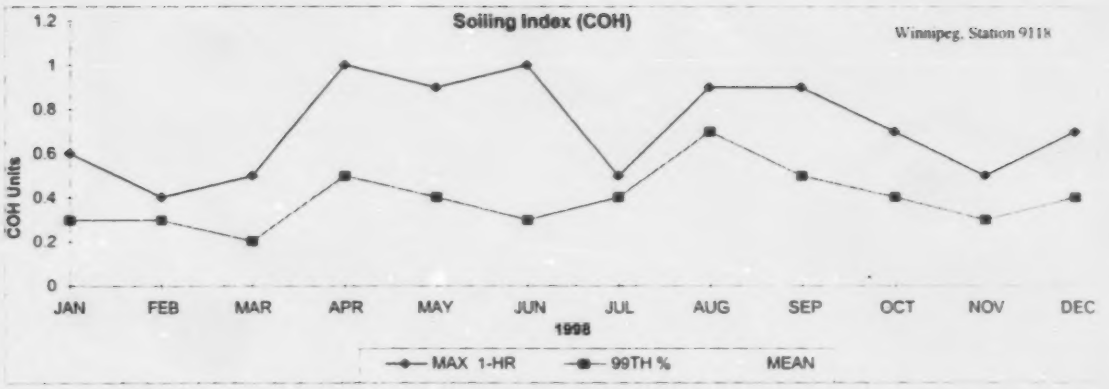

Figure 48 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg residential monitoring site for 1998.

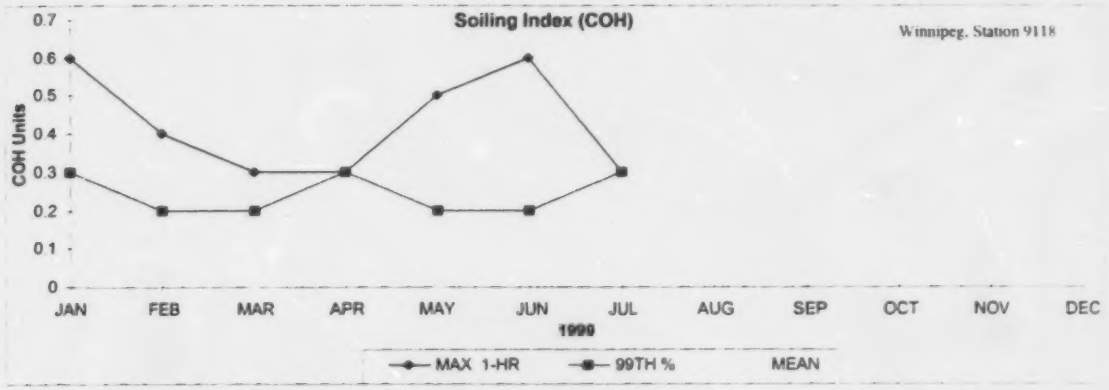

Figure 49 Monthly mean and 1-Hr maximum COH levels calculated and observed for the Winnipeg residential monitoring site for 1999.

Total Suspended Particulate (TSP)

TSP samples, which were collected every sixth day at the residential monitoring station, number 59 out of a possible 61 samples for 1997. For both 1998 and 1999, 58 out of a possible 61 samples are reported on. Yearly trends are shown in Figure 50 and monthly values are shown in Figures 51, 52 and 53 for 1997, 1998 and 1999, respectively. Most values were generally lower than at the other sites monitored by the Department. There were no exceedences of the 24-hour MAL being observed in 1997 (Figure 54), while there was one exceedence in both 1998 and 1999. These exceedences occurred in the early spring of each year and could be attributed to vehicle entrainment of winter road dust which had not been swept up as yet. Both of these exceedences corresponded to exceedences at the downtown station on the same day.

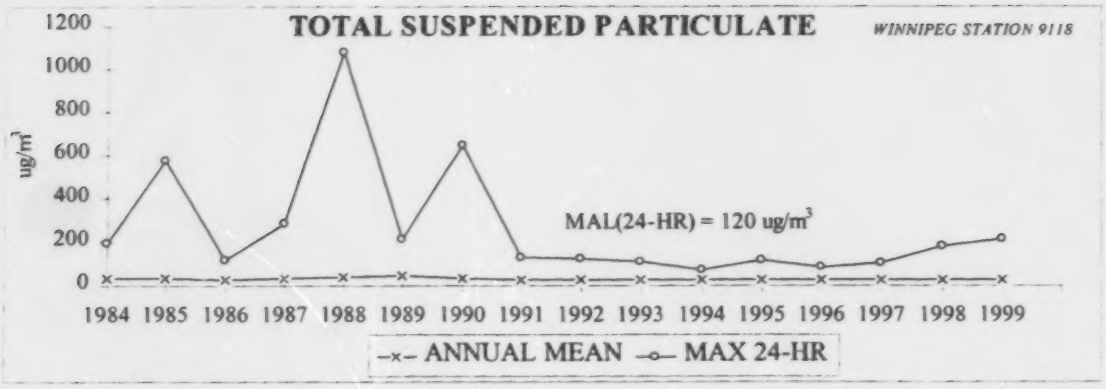

Figure 50 Annual and 24-Hr maximum TSP levels calculated and observed for the Winnipeg residential monitoring site for the period 1984 through 1999.

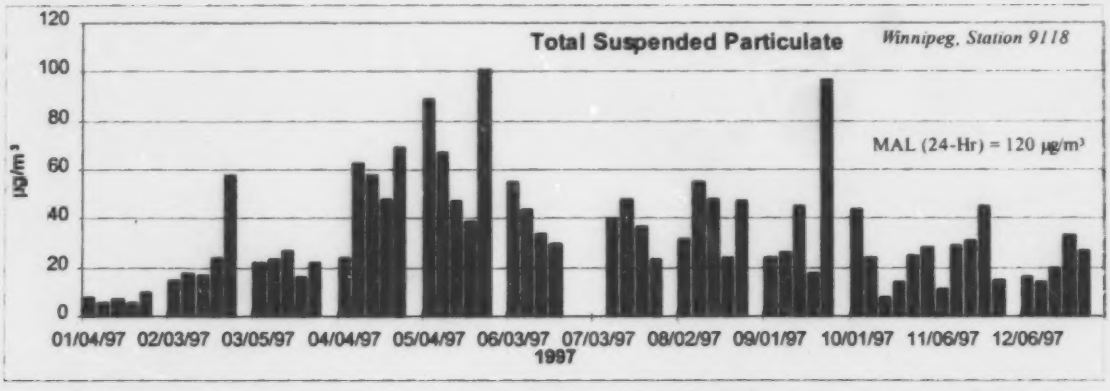

Figure 51 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg residential monitoring site for 1997.

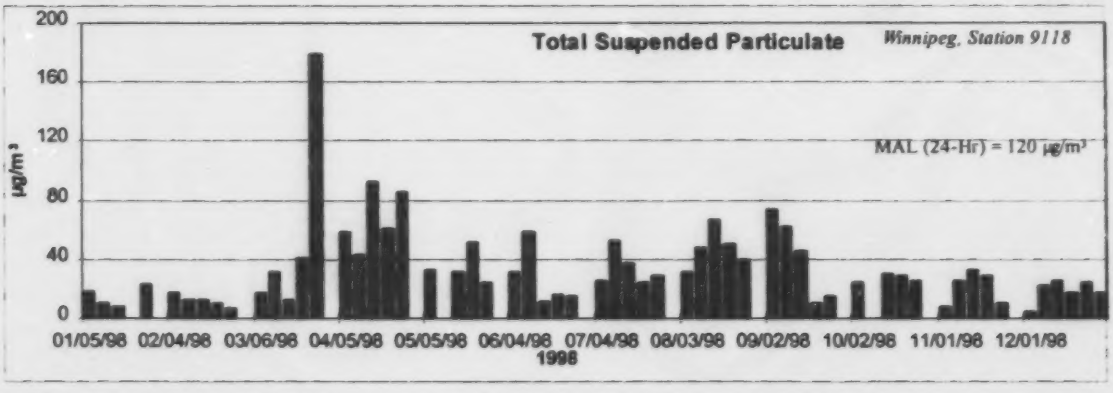

Figure 52 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg residential monitoring site for 1998.

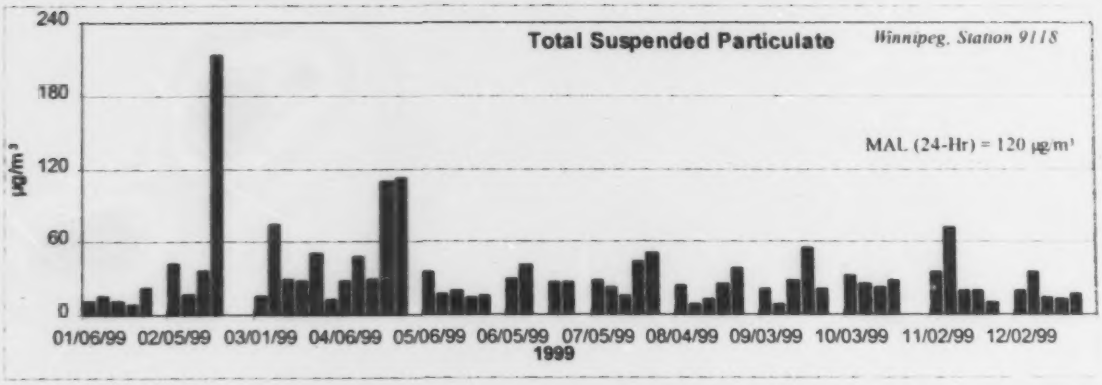

Figure 53 Volume-weighted 24-Hr TSP levels calculated and observed for the Winnipeg residential monitoring site for 1999.

Figure 54 Number of exceedences of the 24-hour MAL (120 µg/m³) observed for the Winnipeg residential monitoring site for the period 1984 through 1999 on an annual basis.

Inhalable Particulates ($PM_{10-2.5}$)

PM_{10} monitoring at the residential station continued until September 4th, 1997 when the R&P TEOM sampler was converted to a $PM_{2.5}$ sampler. The $PM_{2.5}$ sampler came on-line on September 5th, 1997. The hourly and daily average PM_{10} level as determined by the TEOM unit are shown in Figures 55a and b for 1997. The hourly and daily average $PM_{2.5}$ level as determined by the TEOM unit are shown in Figures 56a and b, 57a and b and 58a and b for 1997, 1998 and 1999, respectively. Yearly statistical results are shown in Tables 4a for PM_{10} data for 1997, and 4b, 6b and 8b for $PM_{2.5}$ data for 1997, 1998 and 1999, respectively. Objectives or guidelines for these parameters have not been established.

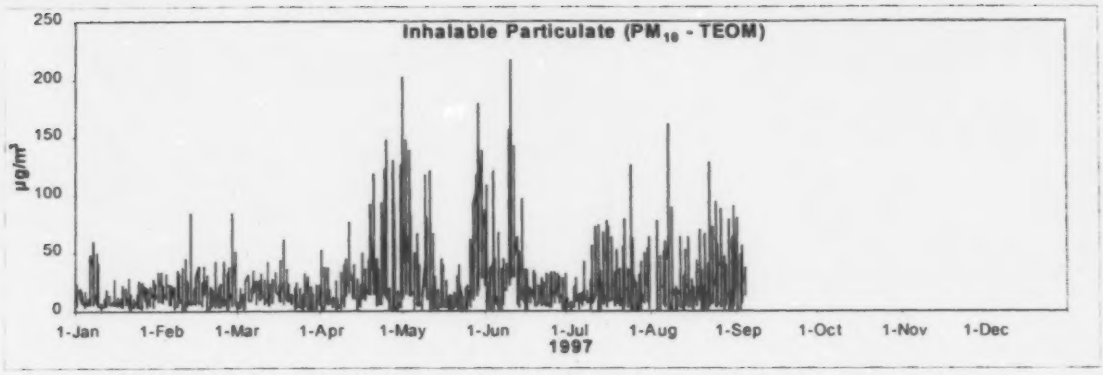

Figure 55a Inhalable particulate (PM10) levels - Hourly averages for 1997. The TEOM unit was converted from a PM10 to a PM2.5 unit on September 4/5, 1997.

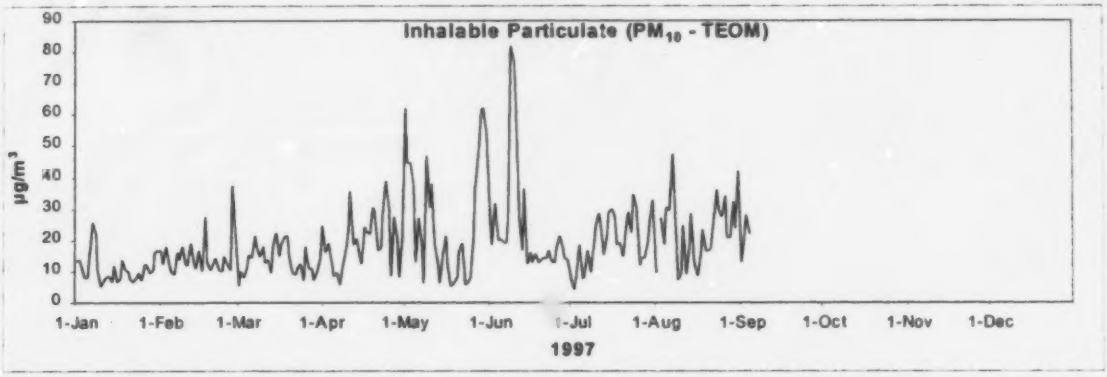

Figure 55b Inhalable particulate (PM10) levels - Daily averages for 1997. The TEOM unit was converted from a PM10 to a PM2.5 unit on September 4/5, 1997.

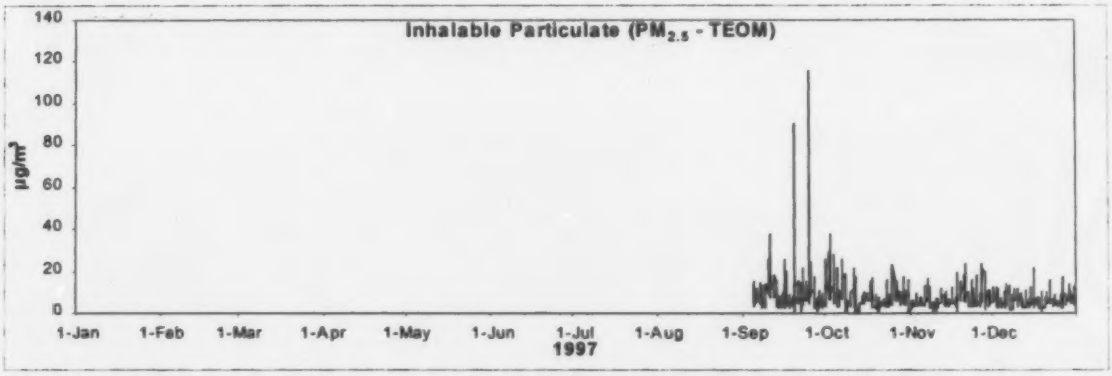

Figure 56a Inhalable particulate (PM2.5) levels - Hourly averages for 1997. The TEOM unit was converted from a PM10 to a PM2.5 unit on September 4/5, 1997.

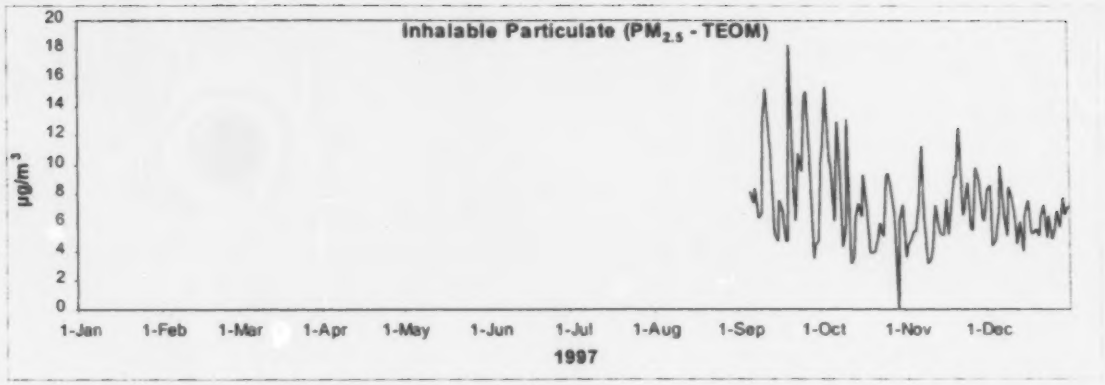

Figure 56b Inhalable particulate (PM2.5) levels - Daily averages for 1997. The TEOM unit was converted from a PM10 to a PM2.5 unit on September 4/5, 1997.

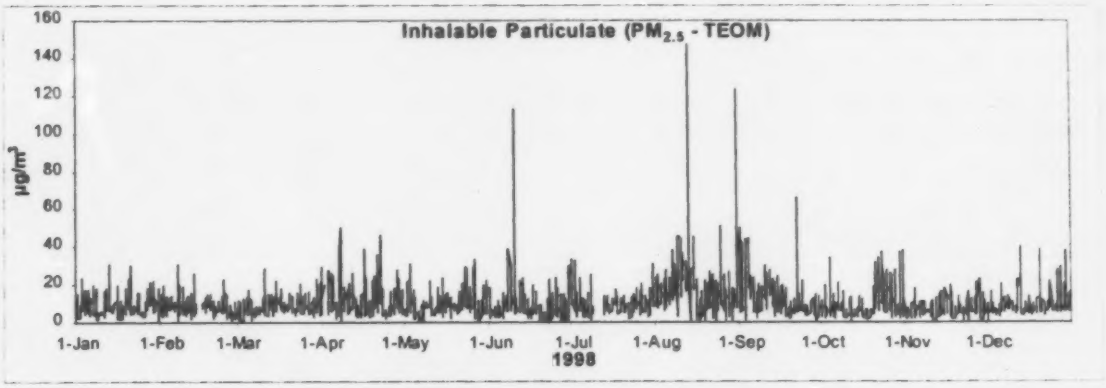

Figure 57a Inhalable particulate (PM2.5) levels - Hourly averages for 1998.

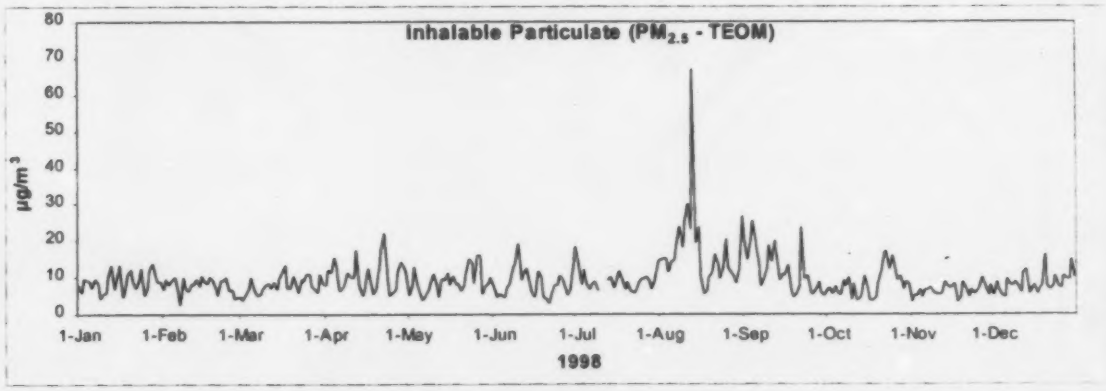

Figure 57b Inhalable particulate (PM2.5) levels - Daily averages for 1998.

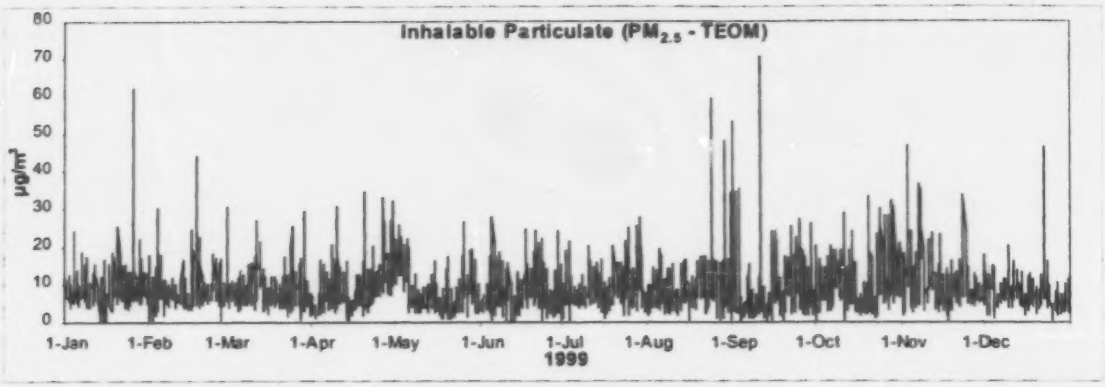

Figure 58a Inhalable particulate (PM2.5) levels - Hourly averages for 1999.

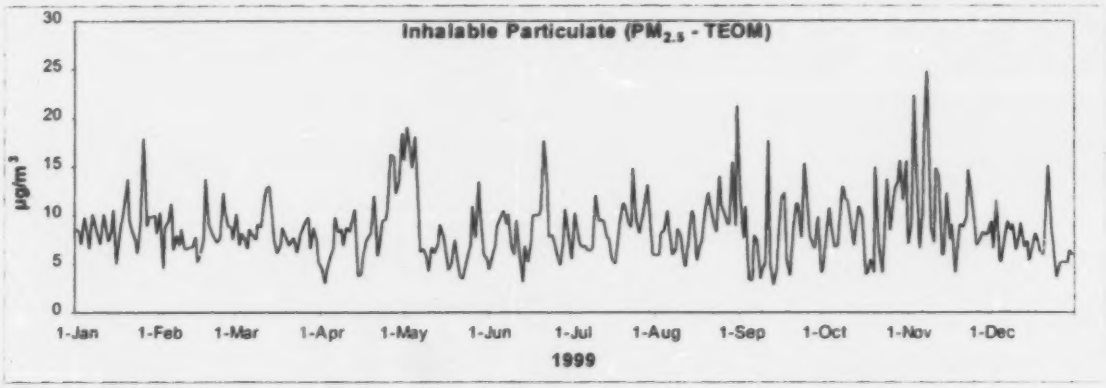

Figure 58b Inhalable particulate (PM2.5) levels - Daily averages for 1999.

B. BRANDON AIR QUALITY

Downtown

Air quality in downtown Brandon was sampled solely for TSP at site #9201 (1104 Princess Avenue), a NAPS Class 2 site. Hi-Vol TSP sampling in downtown Brandon was discontinued at the end of September, 1999 due to the loss of location.

The TSP monthly levels at this location are shown in Figures 59, 60 and 61. The mean values (Figure 62), listed in Tables 4c, 6c and 8c were similar to the Winnipeg residential site and have decreased over the last five years. No samples above the 24-hour MAL were recorded in 1997, 1998 or 1999 (Figure 63).

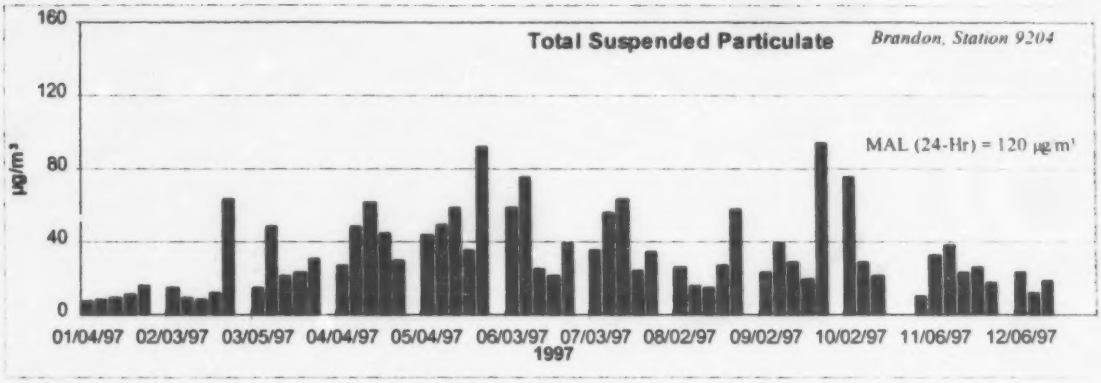

Figure 59. Volume-weighted 24-Hr TSP levels calculated and observed for the Brandon downtown monitoring site for 1997.

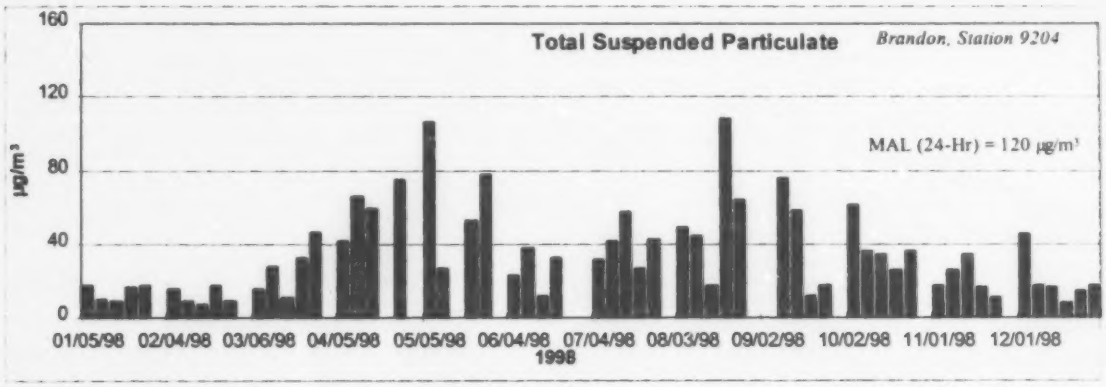

Figure 60. Volume-weighted 24-Hr TSP levels calculated and observed for the Brandon downtown monitoring site for 1998.

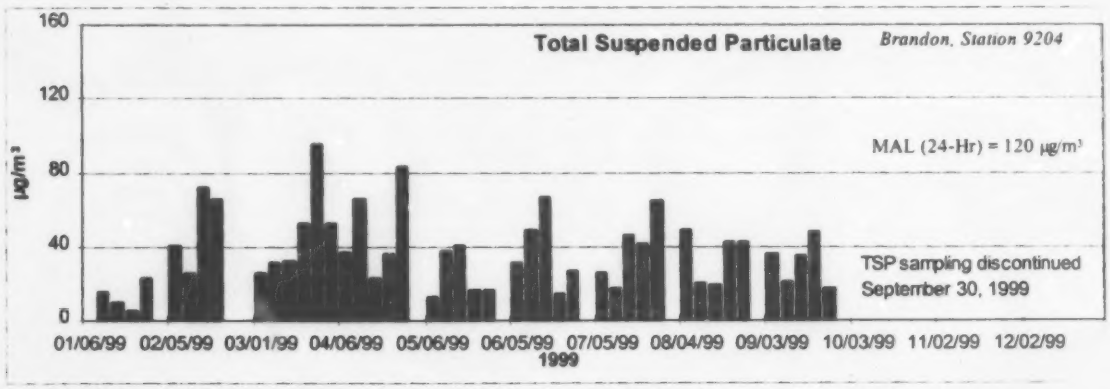

Figure 61. Volume-weighted 24-Hr TSP levels calculated and observed for the Brandon downtown monitoring site for 1999.

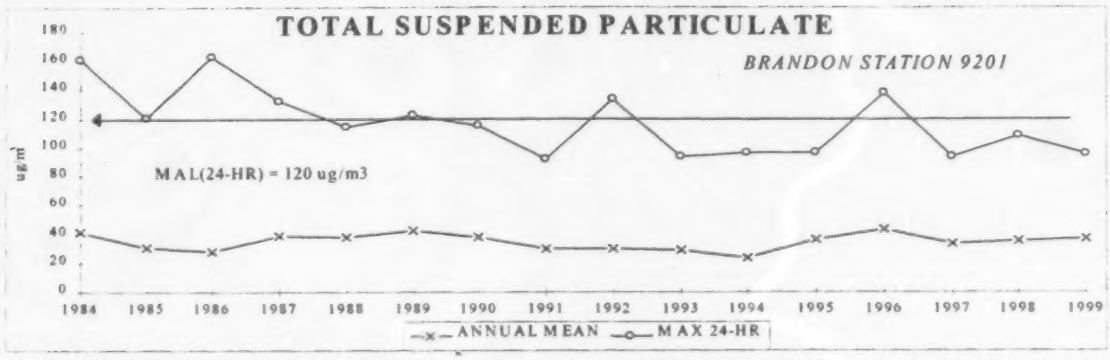

Figure 62. Annual and 24-Hr maximum TSP levels calculated and observed for the Brandon downtown monitoring site for the period 1984 through 1999.

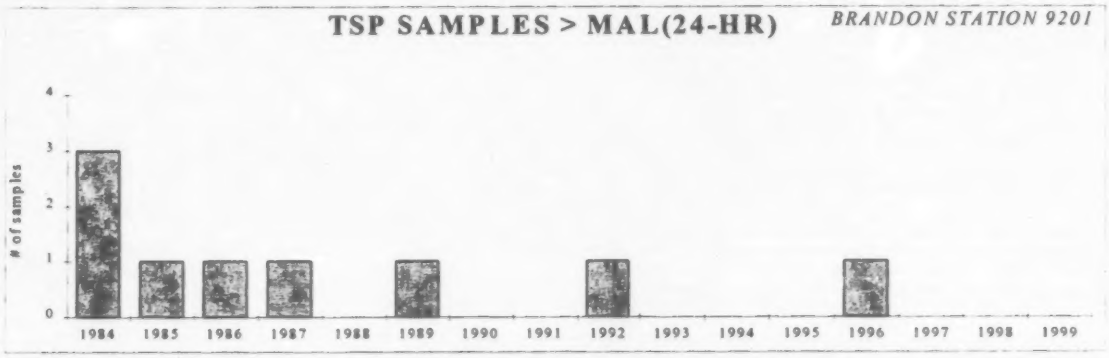

Figure 63 Number of exceedences of the 24-hour MAL (120 µg/m3) observed for the Brandon downtown monitoring site for the period 1984 through 1999 on an annual basis.

Industrial

Air quality in the eastern industrial area of Brandon was monitored at station #5131 on the grounds of Assiniboine Community College. This station monitored NO_x, NO_2, NO, O_3, and NH_3. In 1997 a R&P TEOM PM_{10} analyzer was added to the suite of instruments at the monitoring location.

Air Quality Index

With the addition of the real-time particulate analyzer an AQI was generated for the Brandon Industrial site using the following pollutants: 24-Hr PM_{10}, NH_3, NO_2 and O_3. The Air Quality Index (Figures 64, 65 and 66, Table 16) was in the Good range for 90% of the time in 1997, 1998 and 1999 (discounting N/A times). In 1997, there was only one hour where the Air Quality was Poor, whereas in 1998 and 1999 there were 81 and 32 hours, respectively. As well there were 9 and 16 hours of Very Poor air quality at this location in 1998 and 1999, respectively. In 1997, the AQI calculation was started early in the fourth

quarter of the year. Looking at the summaries for 1998 and 1999 the majority of Fair/Poor/Very Poor air quality events, due to high dust levels, ocurred during the 2nd and 3rd quarters of the year. In 1998, the number of Fair hours was 828 while in 1999 the number of fair hours had dropped to 596. In addition the number of Poor hours dropped from 81 to 32. In all three years, the major influencing factor was ground-level ozone followed by 24-hr PM_{10} and then nitrogen dioxide (a distant third).

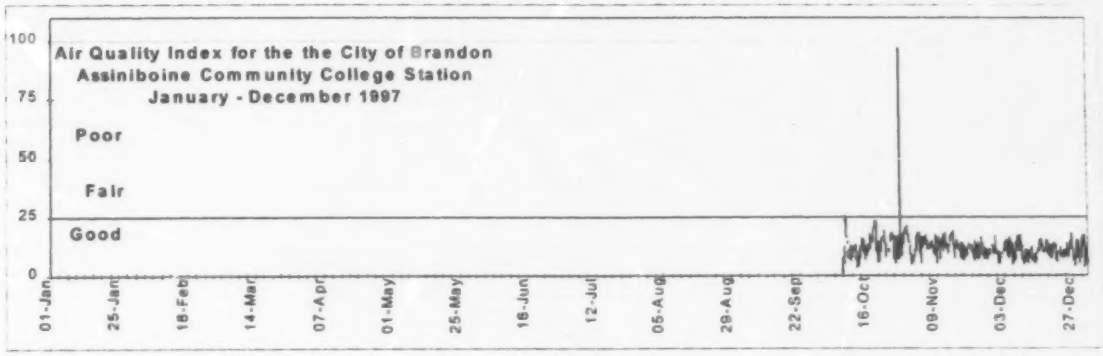

Figure 64. The Air Quality Index for Brandon (Industrial Site) for 1997.

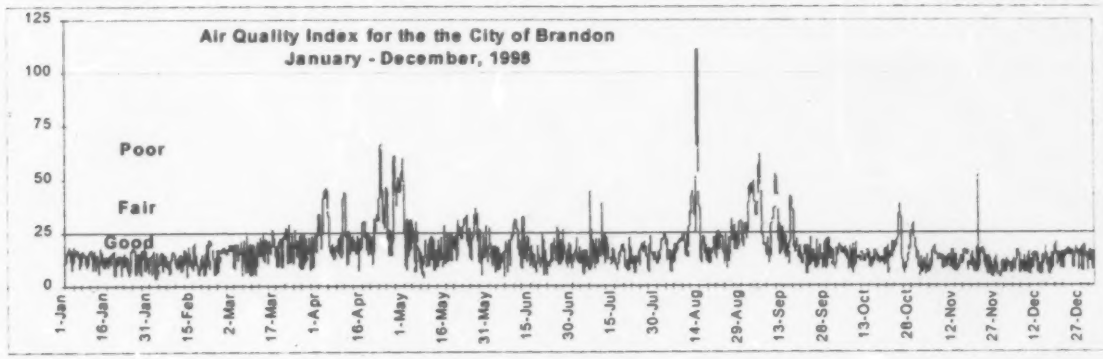

Figure 65. The Air Quality Index for Brandon (Industrial Site) for 1998.

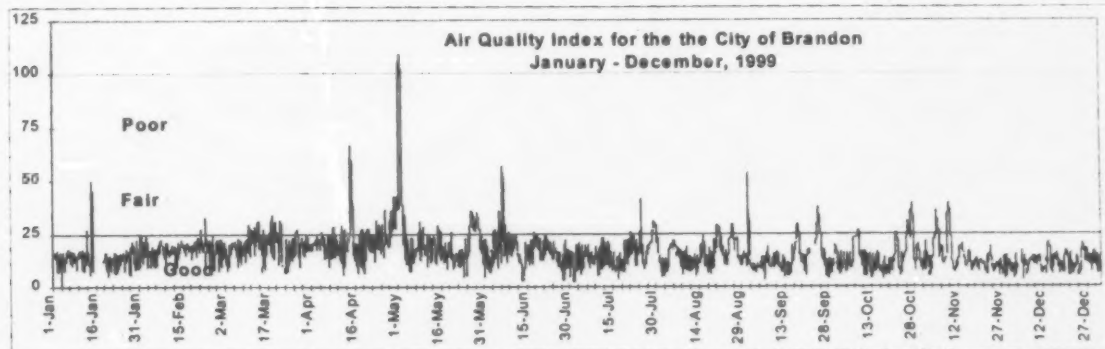

Figure 66. The Air Quality Index for Brandon (Industrial Site) for 1999.

Table 16: Summary of AQI for Brandon (Industrial) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

	Number of Hours					
1997	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	0	0	0	1956	1956	99.8%
Fair	0	0	0	2	2	0.2%
Poor	0	0	0	1	1	0.0%
V.Poor	0	0	0	0	0	0%
N/A	0	0	0	249	249	--
Total	0	0	0	2208	2208	100%
NH_3	0	0	0	13	13	1%
24 PM_{10}	0	0	0	693	693	32%
NO_2	0	0	0	0	0	0%
O_3	0	0	0	1234	1234	56%
N/A	0	0	0	249	249	11%
Total	0	0	0	2189	2189	100%

1998	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	2036	1597	1738	2055	7426	89.0%
Fair	23	449	311	45	828	9.9%
Poor	0	47	33	1	81	1.0%
V.Poor	0	0	9	0	9	0.1%
N/A	101	91	117	107	416	--
Total	2160	2184	2208	2208	8760	100%
NH_3	0	0	3	1	4	0%
24 PM_{10}	186	731	1094	372	2383	27%
NO_2	0	3	0	83	86	1%
O_3	1837	1357	992	1645	5831	67%
N/A	101	91	117	107	416	5%
Total	2124	2182	2206	2208	8720	100%

Table 16: Summary of AQI for Brandon (Industrial) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

	Number of Hours					
1999	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	1886	1744	1941	1974	7545	92.1%
Fair	77	290	123	106	596	7.3%
Poor	0	31	1	0	32	0.4%
V.Poor	0	16	0	0	16	0.2%
N/A	197	103	143	128	571	--
Total	2160	2184	2208	2208	8760	100%
NH3	12	4	1	3	20	0%
24 PM10	88	540	900	1024	2552	29%
NO2	76	9	1	32	118	1%
O3	1787	1528	1162	1021	5498	63%
N/A	197	103	143	128	571	7%
Total	2160	2184	2207	2208	8759	100%

N/A The AQI would not be available 4% of the time or 1 in every 24 hours due to the internal calibrations that occur each day at 3 a.m. CST. Additional N/A times would occur during routine instrument maintenance and repair.

Ozone

Ground level O_3 monthly levels at Brandon site #5131 are shown in Figures 67, 68 and 69. The annual means were higher than the Winnipeg stations and a decrease in levels was observed in 1997 to 1999 as compared to 1995/6. There have been no excursions above the 1-hour MAL (8.2 pphm) since 1986. Yearly trends are shown in Figure 70.

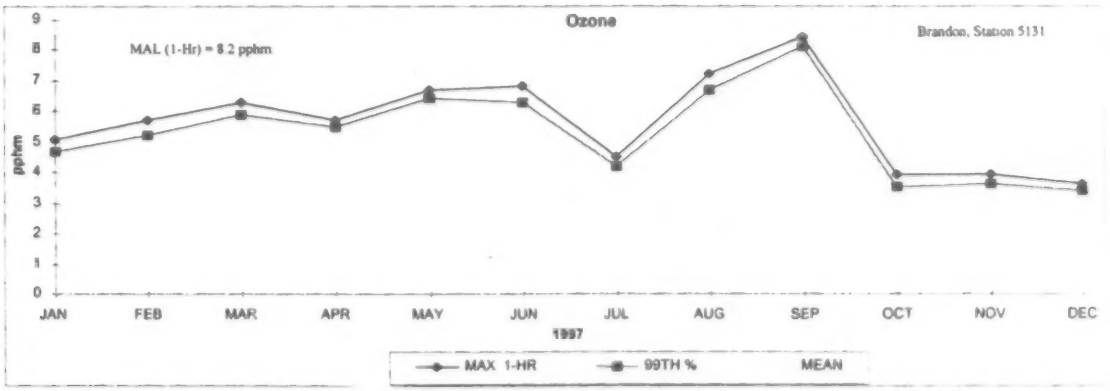

Figure 67. Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Brandon industrial monitoring site for 1997.

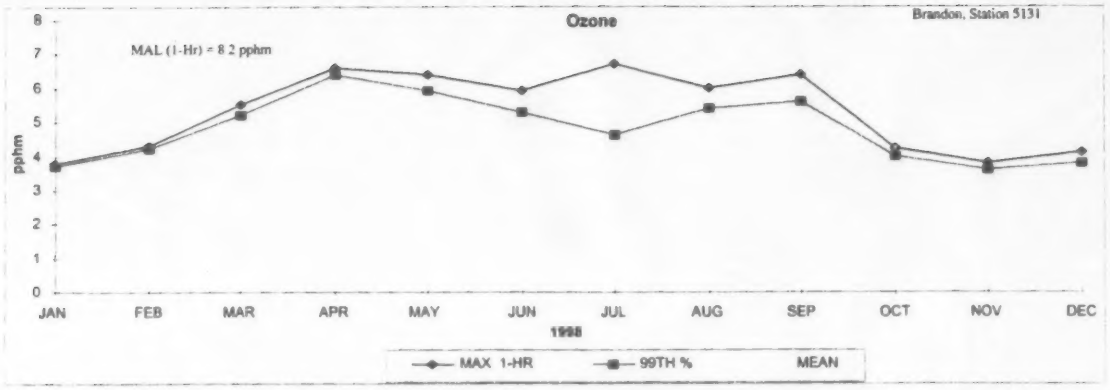

Figure 68. Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Brandon industrial monitoring site for 1998.

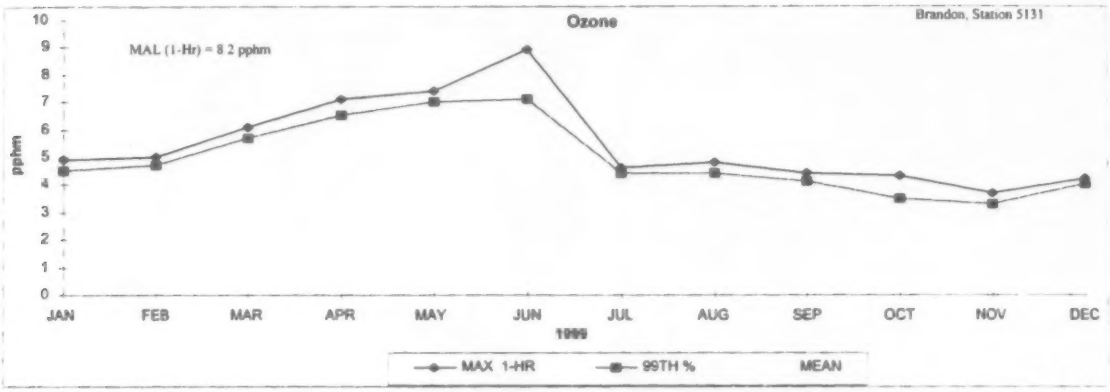

Figure 69. Monthly mean and 1-Hr maximum ground-level ozone levels calculated and observed for the Brandon industrial monitoring site for 1999.

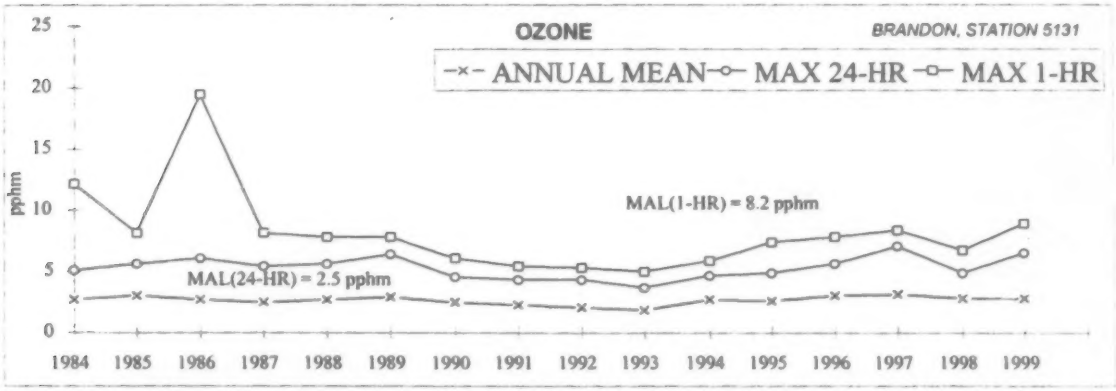

Figure 70. Annual mean, 24-Hr and 1-Hr maximum ground-level ozone levels calculated and observed for the Brandon industrial monitoring site.

Ammonia (NH_3)

NH_3 monitoring at station #5131 is source-specific for air emissions from a fertilizer manufacturer. The monthly levels are shown in Figures 71, 72 and 73, and the yearly trends are shown in Figures 74 and 75. The Manitoba Environment licenced regulatory limit issued to the fertilizer company of 3.0 ppm (1-hour average) was exceeded once each in 1997 and 1998. There were no exceedences of the Licence limit in 1999. The MAL Guideline of 2.0 ppm for any one hour period was exceeded on 5 occasions in 1997, on 2 occasions in 1998 and 6 occasions in 1999.

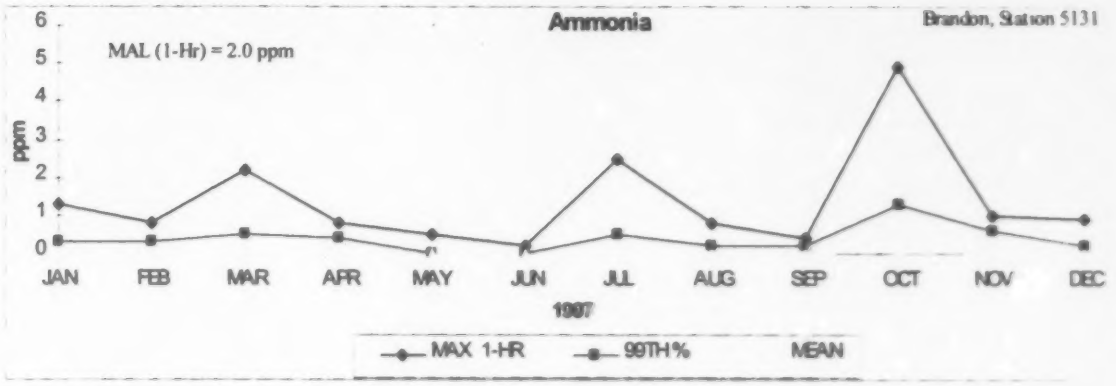

Figure 71. Monthly mean and 1-Hr maximum ammonia levels calculated and observed for the Brandon industrial monitoring site for 1997.

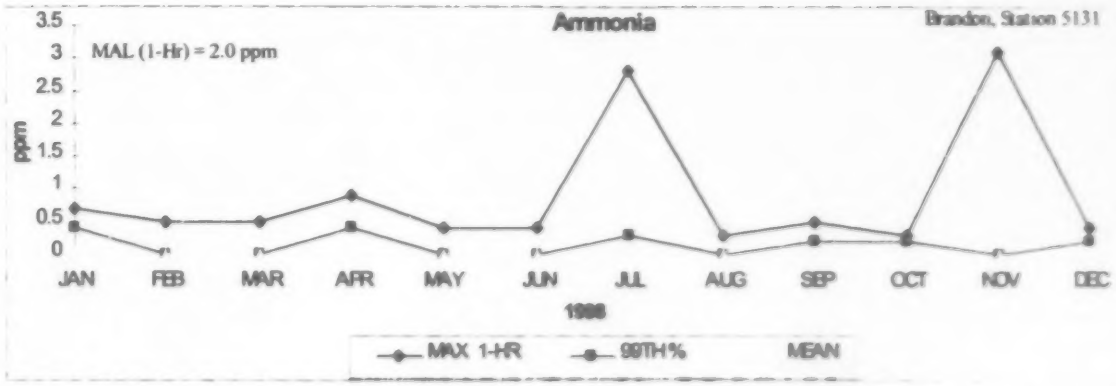

Figure 72. Monthly mean and 1-Hr maximum ammonia levels calculated and observed for the Brandon industrial monitoring site for 1998.

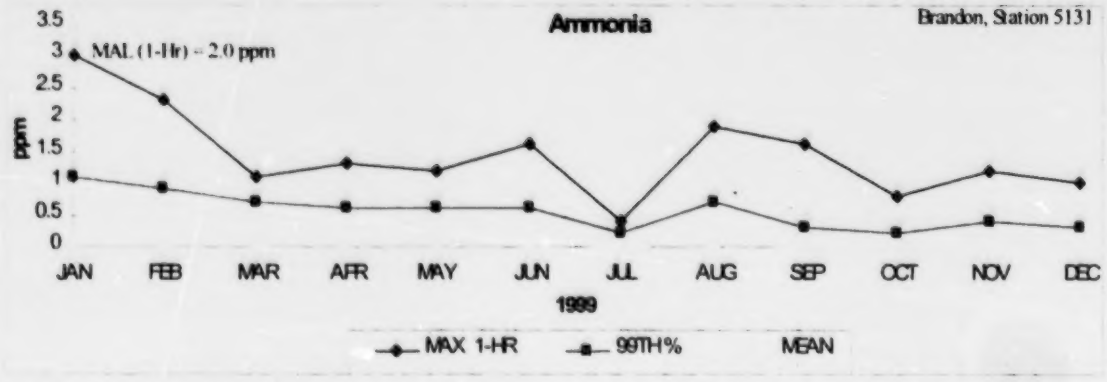

Figure 73. Monthly mean and 1-Hr maximum ammonia levels calculated and observed for the Brandon industrial monitoring site for 1999.

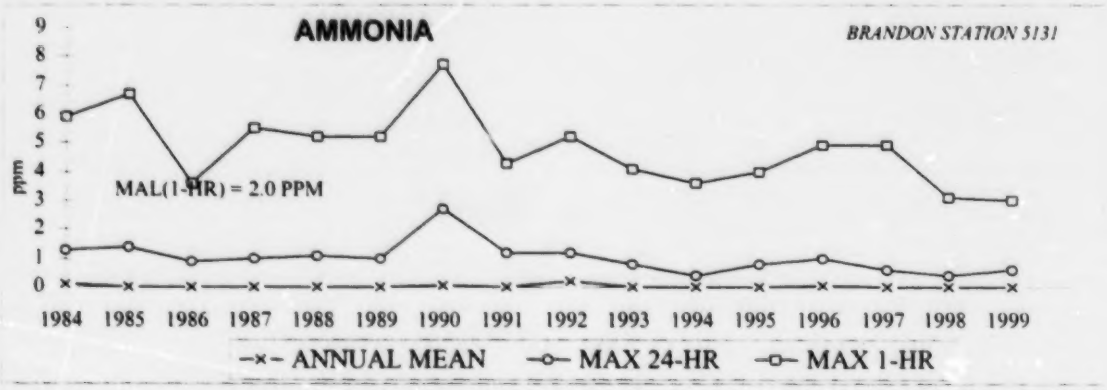

Figure 74. Annual mean, 24-Hr and 1-Hr maximum ammonia levels calculated and observed for the Brandon industrial monitoring site.

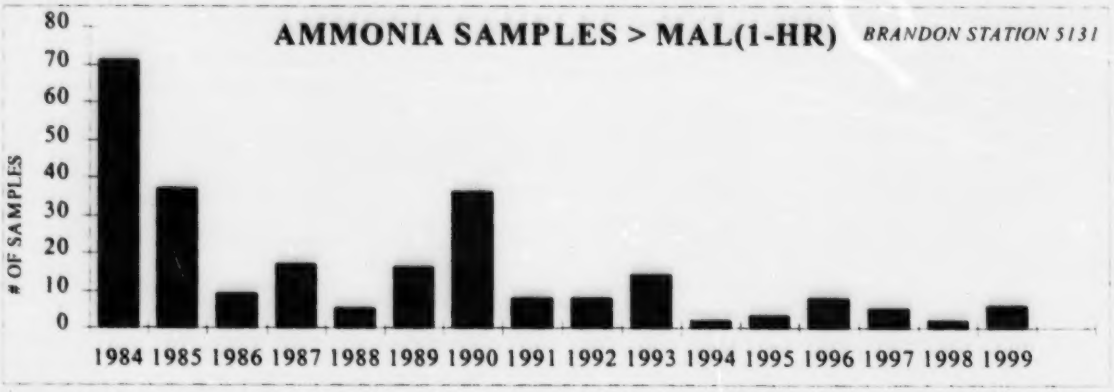

Figure 75. Number of exceedences of the 1-hour MAL (2.0 ppm) observed for the Brandon industrial monitoring site for the period 1984 through 1999 on an annual basis.

F-2

C. FLIN FLON AIR QUALITY

Air Quality Index

With the addition of the real-time particulate analyzer in 1997, an AQI was generated for the downtown Flin Flon site using the following pollutants: 24-Hr PM_{10}, 1- Hr SO_2 and 24-Hr SO_2. *[Cautionary Note - Since a full range of monitoring is not undertaken at this site (i.e., O_3 not monitored) , there is a potential to underestimate the air quality index.]* The Air Quality Index (Figures 76, 77 and 78, Table 17) was in the Good range for over 80% of the time in 1997, 1998 and 1999 (discounting N/A times). During this time period, air quality was Fair no less than 10% of the time (discounting N/A times) and in the Poor range for 3-5% of the time. In 1999, the number of Very Poor hours tripled from 1998. In all three years the major influencing factor was PM_{10} (averaged over 24 hours) followed by 24-hour SO_2 and then 1-hour SO_2 (a distant third).

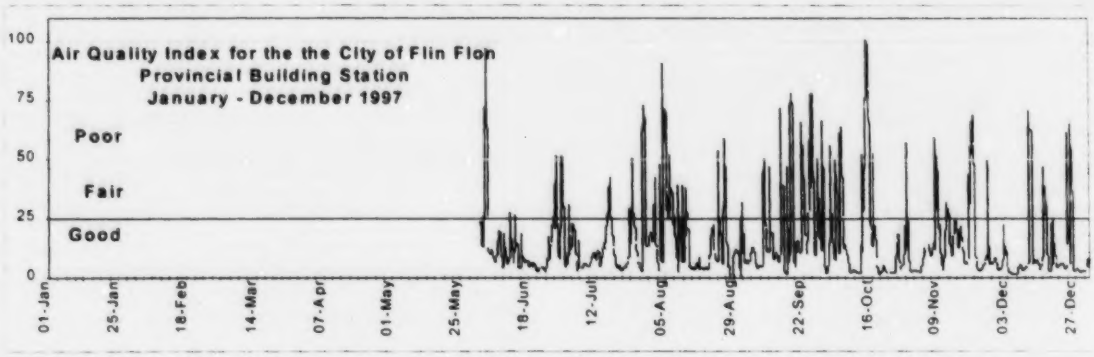

Figure 76. The Air Quality Index for Flin Flon (Downtown Site) for 1997.

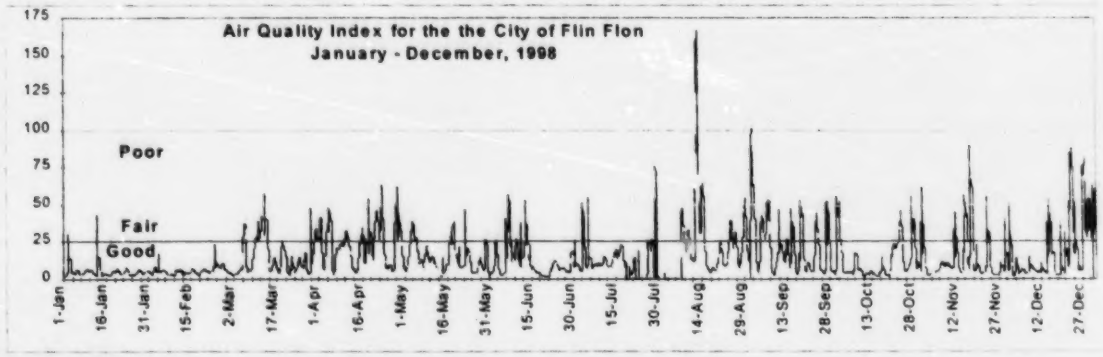

Figure 77. The Air Quality Index for Flin Flon (Downtown Site) for 1998.

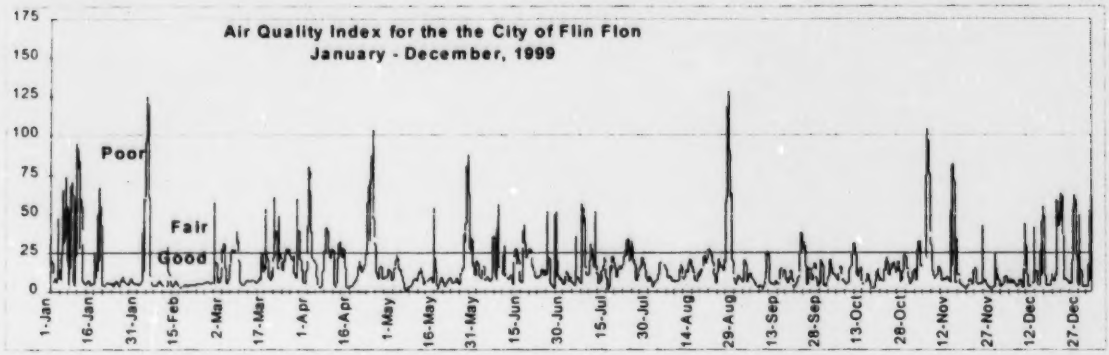

Figure 78. The Air Quality Index for Flin Flon (Downtown Site) for 1999.

Table 17: Summary of AQI for Flin Flon (Downtown) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

	Number of Hours					
1997	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	0	622	1696	1787	4105	84.5%
Fair	0	44	261	183	488	10.0%
Poor	0	24	121	119	264	5.5%
V.Poor	0	0	0	2	2	0.0%
N/A	0	30	130	117	277	--
Total	0	720	2208	2208	5136	100%
SO_2	0	22	101	76	199	4%
24 SO_2	0	168	378	383	929	18%
24 PM_{10}	0	500	1599	1632	3731	73%
N/A	0	30	130	117	277	5%
Total	0	720	2208	2208	5136	100%

1998	1st Qtr	2 nd Qtr	3 rd Qtr	4 th Qtr	Total	%
Good	1903	1625	1329	1725	6582	82.2%
Fair	159	425	358	234	1176	14.6%
Poor	2	18	85	133	238	3.0%
V.Poor	0	0	15	0	15	0.2%
N/A	96	116	419	116	747	--
Total	2160	2184	2206	2208	8758	100%
SO_2	27	37	62	90	216	2%
24 SO_2	65	104	209	455	833	10%
24 PM_{10}	1972	1927	1518	1547	6964	79%
N/A	96	116	419	116	747	9%
Total	2160	2184	2208	2208	8760	100%

Table 17: Summary of AQI for Flin Flon (Downtown) by Category and determining Pollutant for 1997, 1998 and 1999 (by quarters).

	Number of Hours					
1999	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Total	%
Good	1664	1689	1900	1846	7099	85.7%
Fair	226	277	150	121	774	9.3%
Poor	132	86	23	124	365	4.4%
V.Poor	19	4	21	3	47	0.6%
N/A	119	128	114	114	475	--
Total	2160	2184	2208	2208	8760	100%
SO_2	77	20	24	55	176	2%
24 SO_2	358	101	52	281	792	9%
24 PM_{10}	1606	1935	2018	1758	7317	86%
N/A	119	128	114	114	475	6%
Total	2160	2184	2207	2208	8759	100%

N/A The AQI would not be available 4% of the time or 1 in every 24 hours due to the internal calibrations that occur each day at 3 a.m. CST. Additional N/A times would occur during routine instrument maintenance and repair.

Sulphur Dioxide (SO_2)

SO_2 is monitored in Flin Flon by the Province at 143 Main Street, located in downtown Flin Flon. The primary source of SO_2 is a major zinc-copper smelter located near the downtown area, straddling the Manitoba-Saskatchewan border. This company maintained four monitoring sites of its own.

Reported SO_2 emissions for 1997, 1998 and 1999 from this complex were 178,924.5, 185,171.8 and 187,559.1 tonnes per year, respectively. At the downtown site there were 105 excursions above the 1-hour MAL of 0.34 ppm in 1997, 64 in 1998 and 80 exceedences in 1999. Monthly and yearly data are shown in Figures 79 to 84 and Tables 3, 5 and 7. Yearly trends are shown in Figures 85 and 86. For comparison purposes, monthly data for the four company-operated monitoring sites is included (Figures 87 to 110).

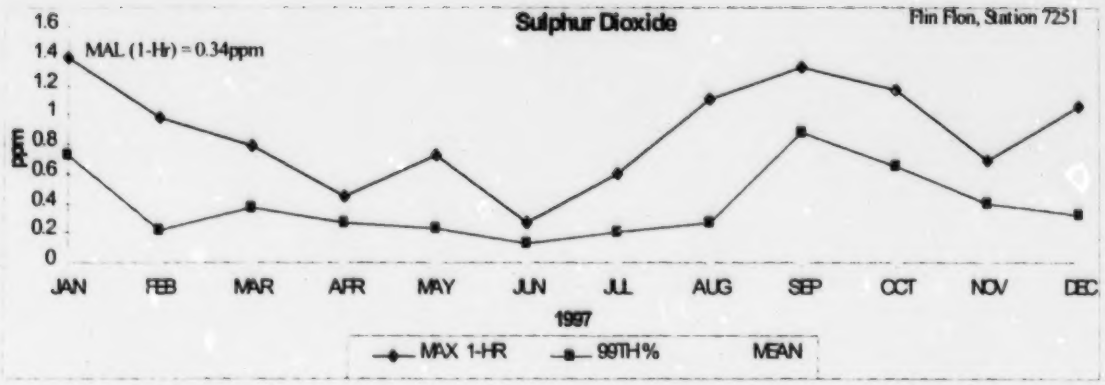

Figure 79. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the Flin Flon Provincial monitoring site for 1997.

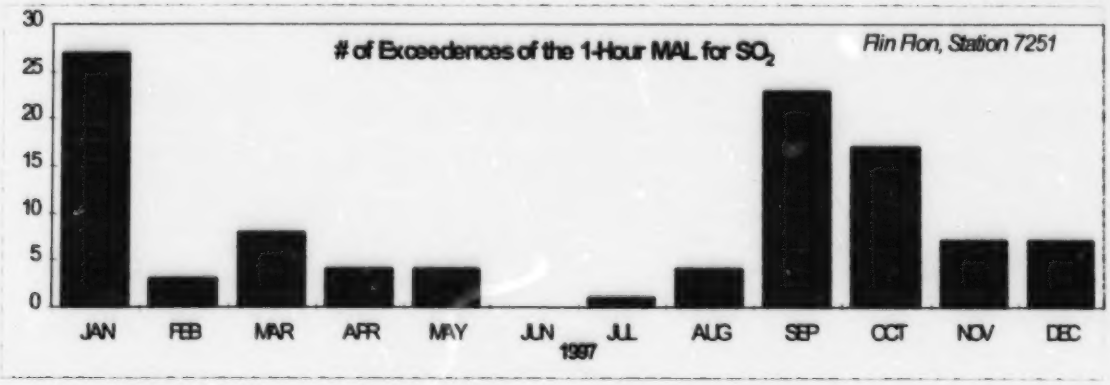

Figure 80. Number of exceedences of the 1-hour MAL for SO_2 for 1997 recorded at the Provincial monitoring site.

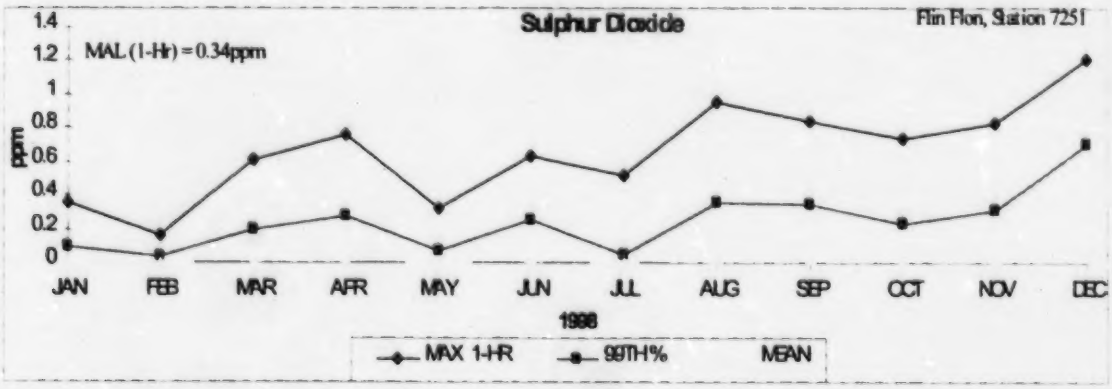

Figure 81 Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the Flin Flon provincial monitoring site for 1998.

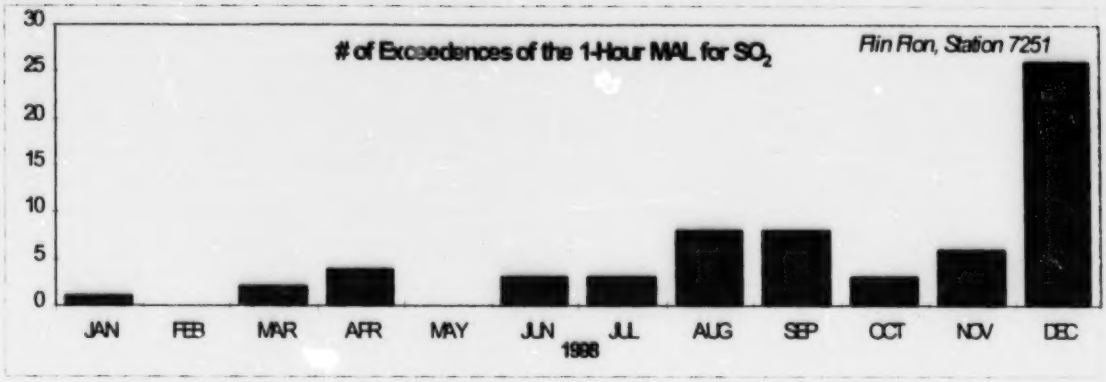

Figure 82. Number of exceedences of the 1-hour MAL for SO_2 for 1998 recorded at the provincial monitoring site.

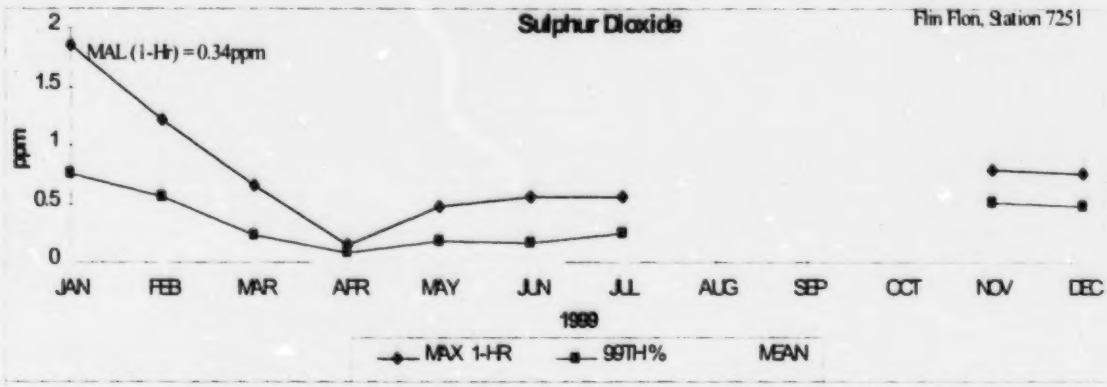

Figure 83. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the Flin Flon provincial monitoring site for 1999.

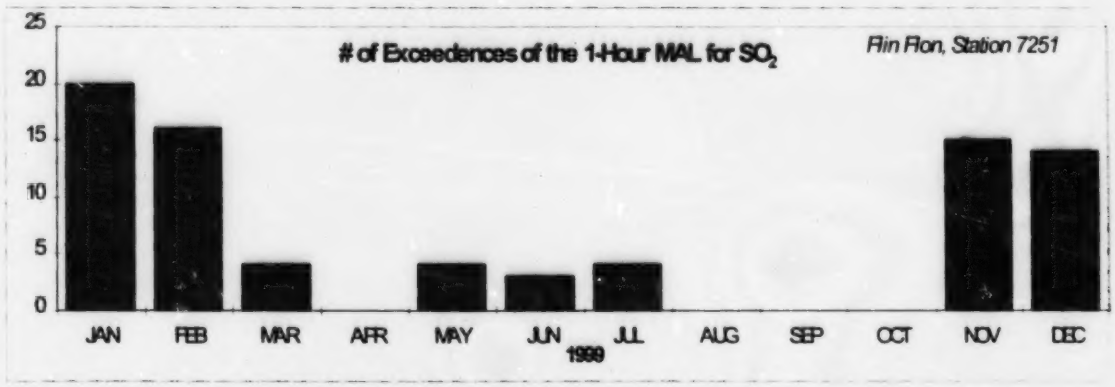

Figure 84. Number of exceedences of the 1-hour MAL for SO_2 for 1999 recorded at the provincial monitoring site.

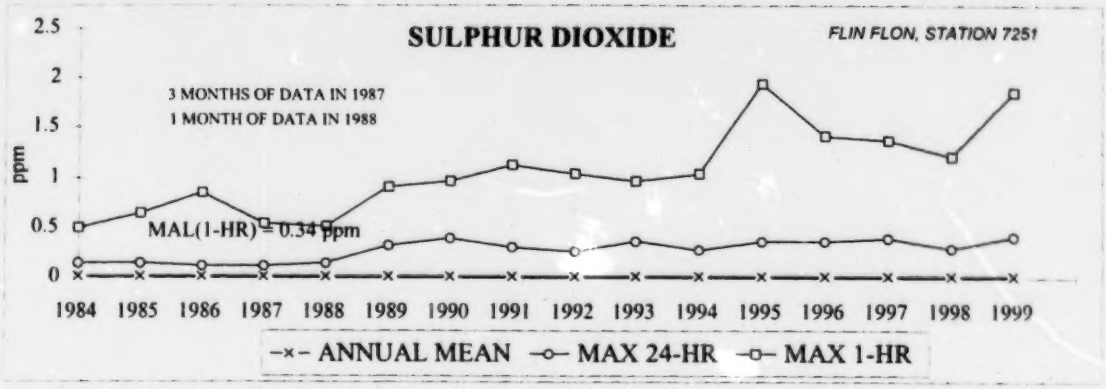

Figure 85. Annual mean, 24-Hr and 1-Hr maximum sulphur dioxide levels calculated and observed for the Flin Flon provincial monitoring site from 1984 through 1999.

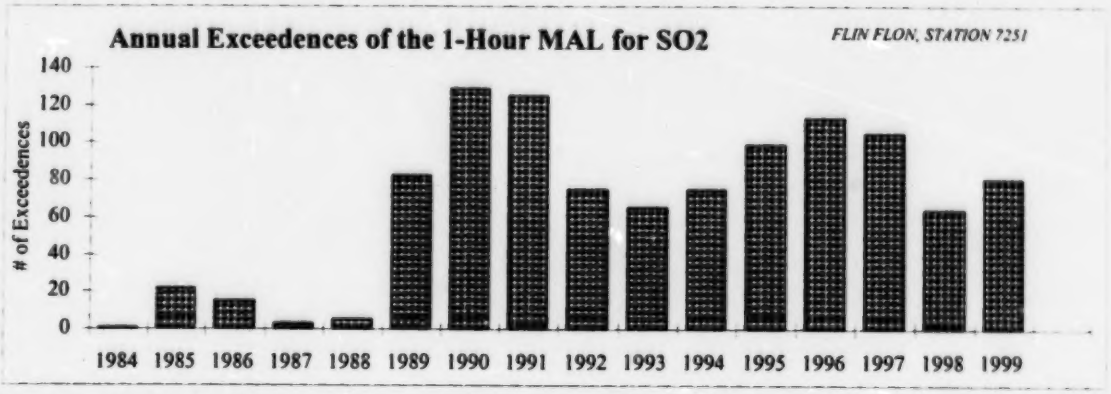

Figure 86. Number of exceedences of the 1-hour MAL for SO_2 recorded at the provincial monitoring site on an annual basis from 1984 through 1999. *Note: The location of monitoring in the uptown area changed in 1989.*

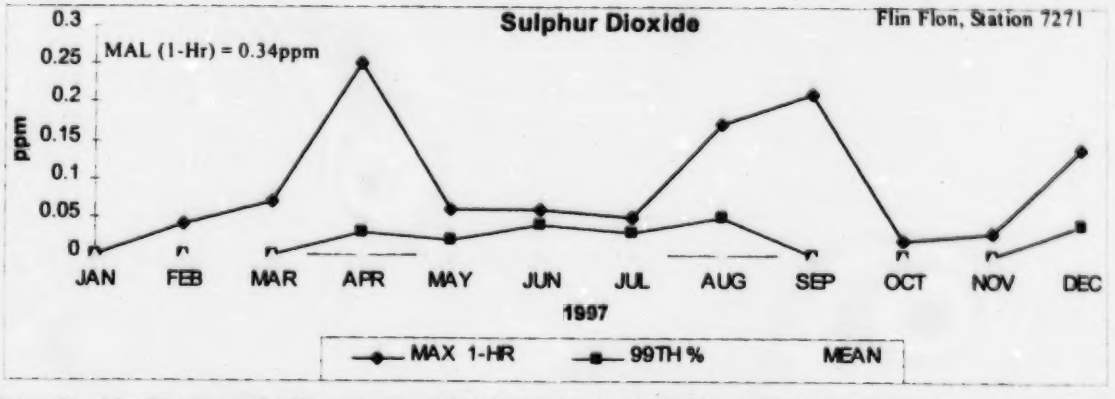

Figure 87. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Aqua Centre in Flin Flon, for 1997.

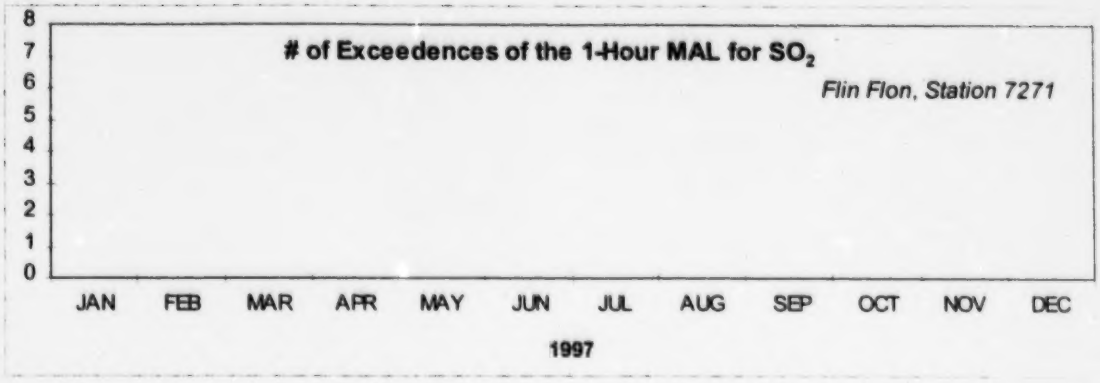

Figure 88. Number of exceedences of the 1-hour MAL for SO_2 for 1997 recorded at the company monitoring site located at the Aqua Centre in Flin Flon.

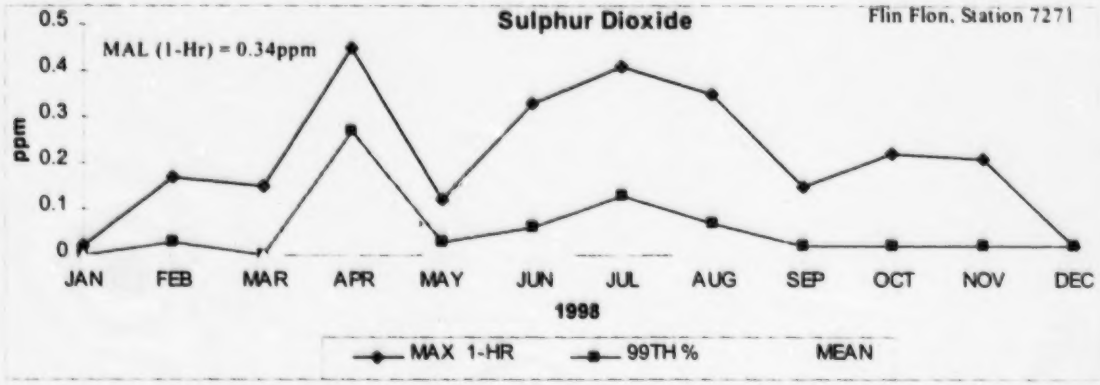

Figure 89. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Aqua Centre in Flin Flon, for 1998.

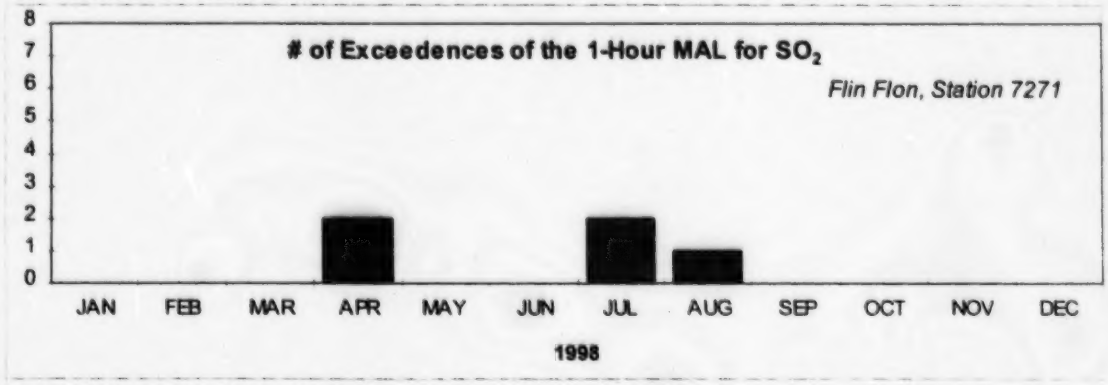

Figure 90. Number of exceedences of the 1-hour MAL for SO_2 for 1998 recorded at the company monitoring site located at the Aqua Centre in Flin Flon.

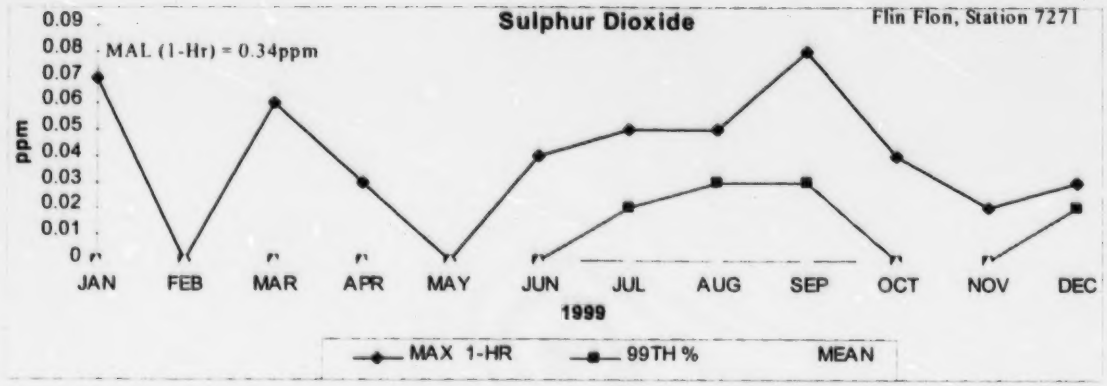

Figure 91. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Aqua Centre in Flin Flon, for 1999.

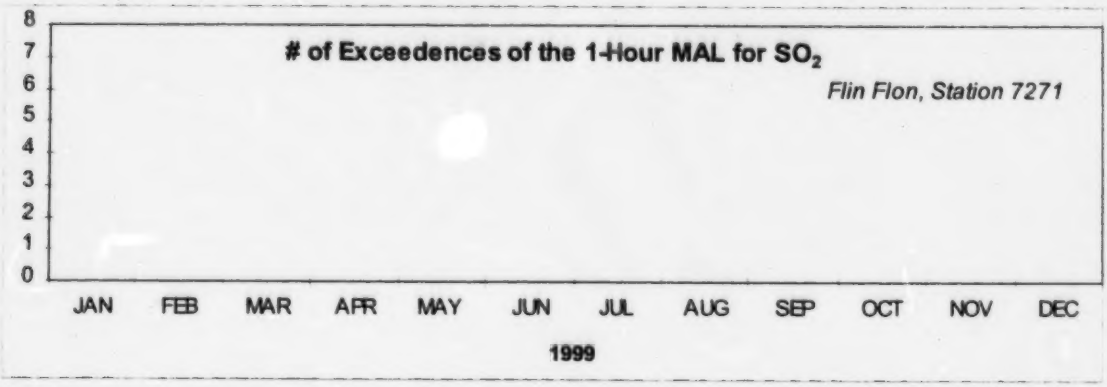

Figure 92. Number of exceedences of the 1-hour MAL for SO_2 for 1999 recorded at the company monitoring site located at the Aqua Centre in Flin Flon.

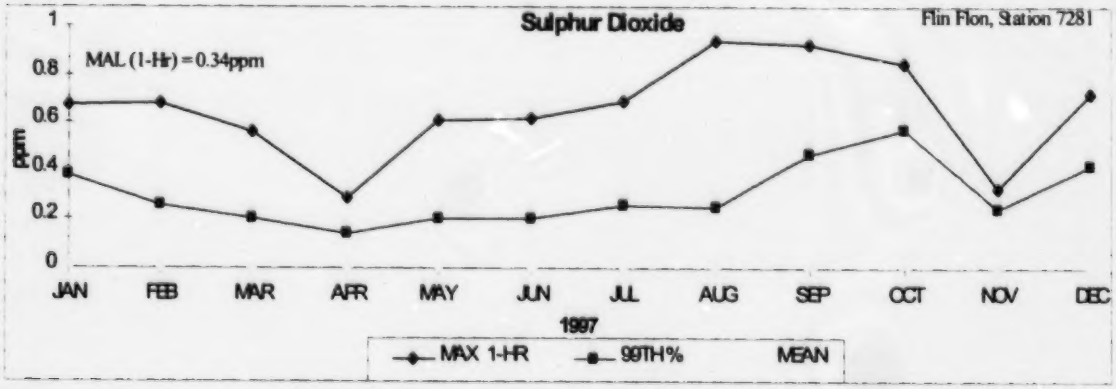

Figure 93. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the HBM&S Staff House in Flin Flon, for 1997.

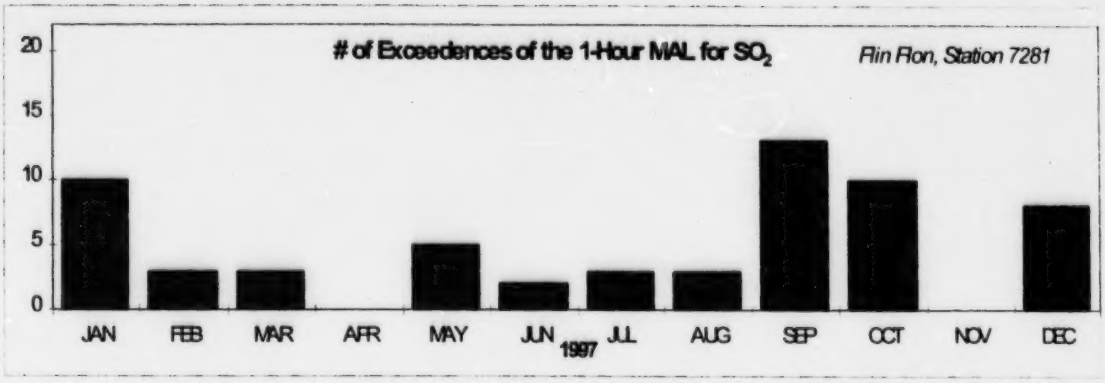

Figure 94. Number of exceedences of the 1-hour MAL for SO_2 for 1997 recorded at the company monitoring site located at the HBM&S Staff House in Flin Flon.

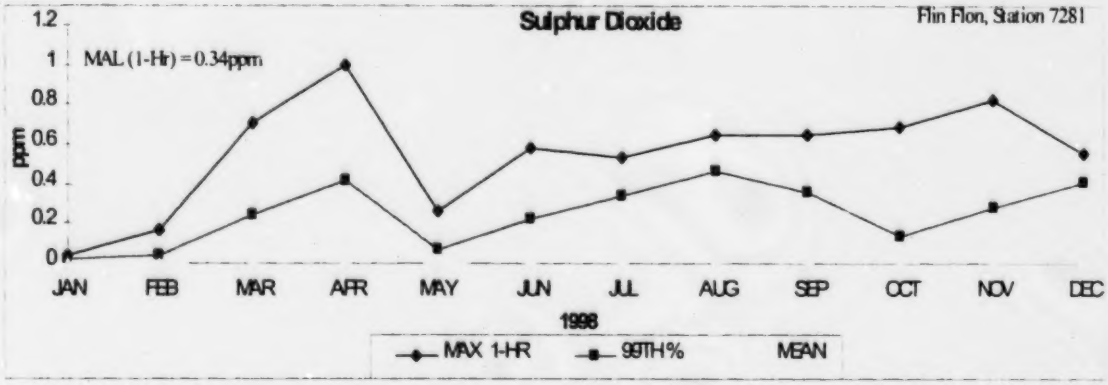

Figure 95. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the HBM&S Staff House in Flin Flon, for 1998.

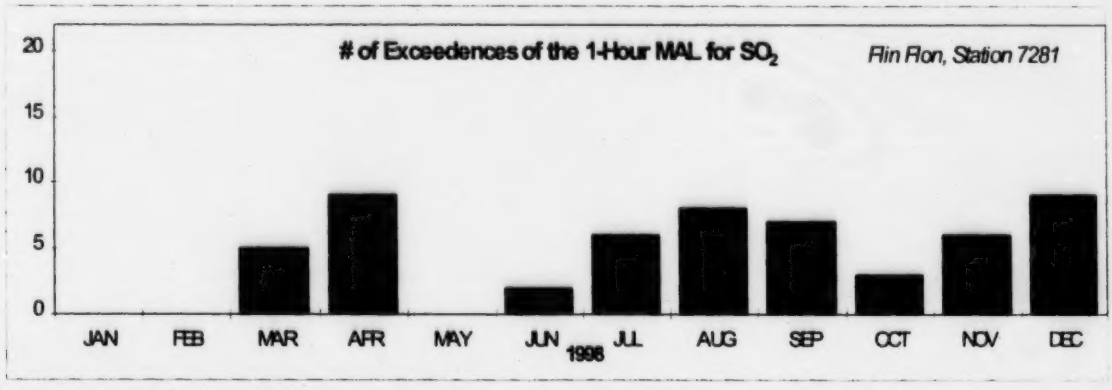

Figure 96. Number of exceedences of the 1-hour MAL for SO_2 for 1998 recorded at the company monitoring site located at the HBM&S Staff House in Flin Flon.

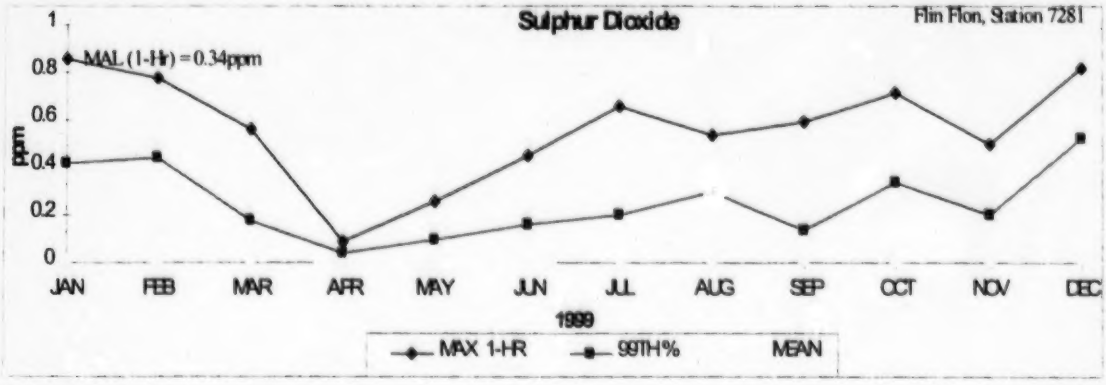

Figure 97. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the HBM&S Staff House in Flin Flon, for 1999.

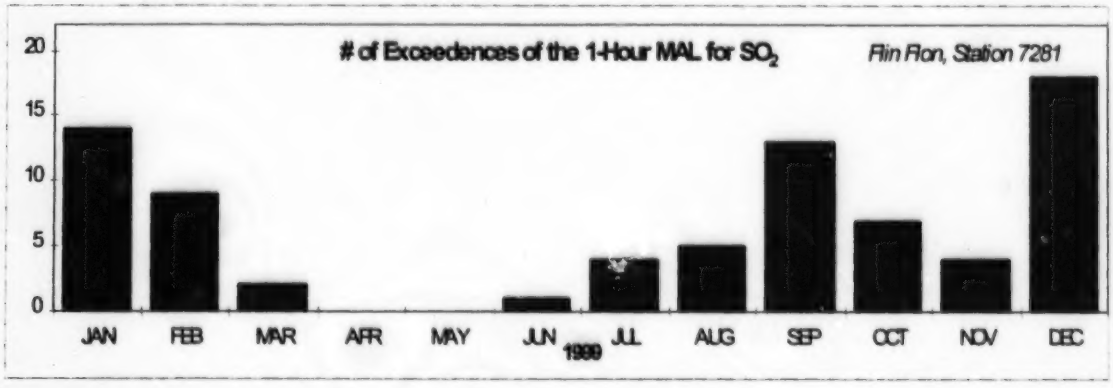

Figure 98. Number of exceedences of the 1-hour MAL for SO_2 for 1999 recorded at the company monitoring site located at the HBM&S Staff House in Flin Flon.

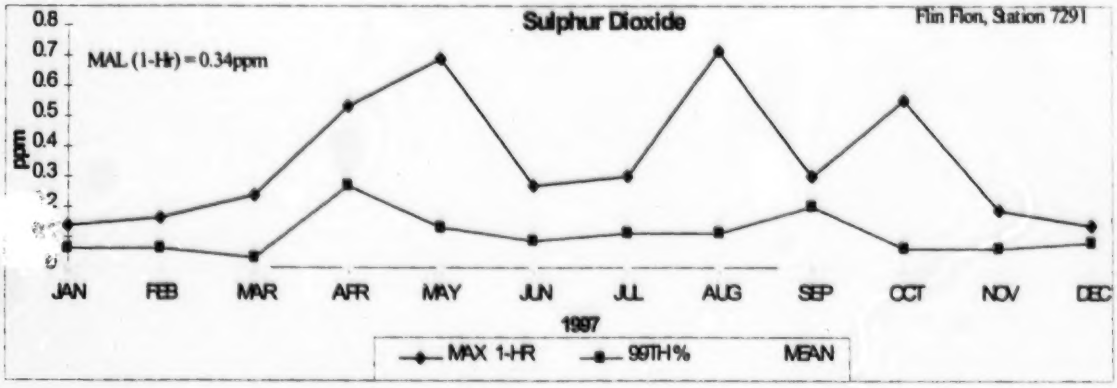

Figure 99. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Creighton (Sask.) City Fire Hall, for 1997.

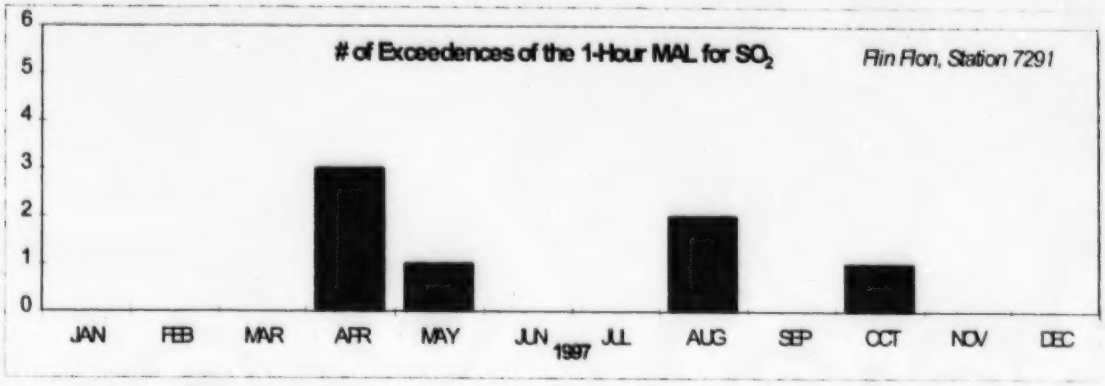

Figure 100. Number of exceedences of the 1-hour MAL for SO_2 for 1997 recorded at the company monitoring site located at the City Fire Hall in Creighton, Sask.

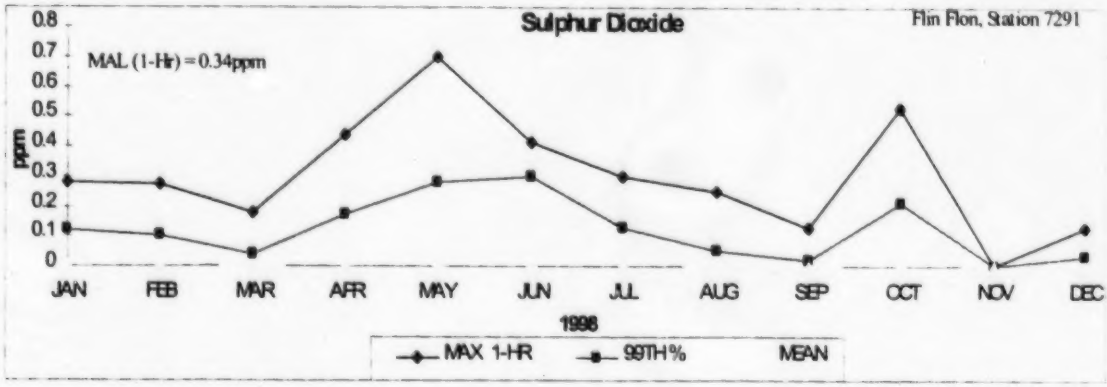

Figure 101. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Creighton (Sask.) City Fire Hall, for 1998.

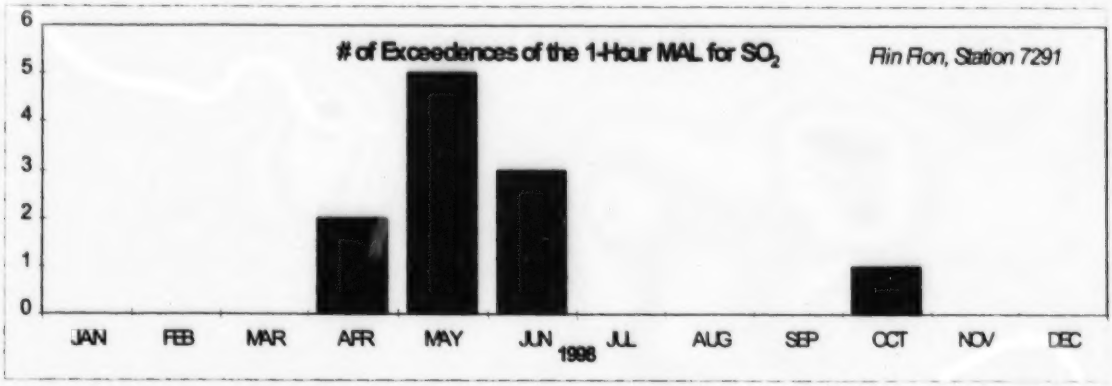

Figure 102. Number of exceedences of the 1-hour MAL for SO_2 for 1998 recorded at the company monitoring site located at the City Fire Hall in Creighton, Sask.

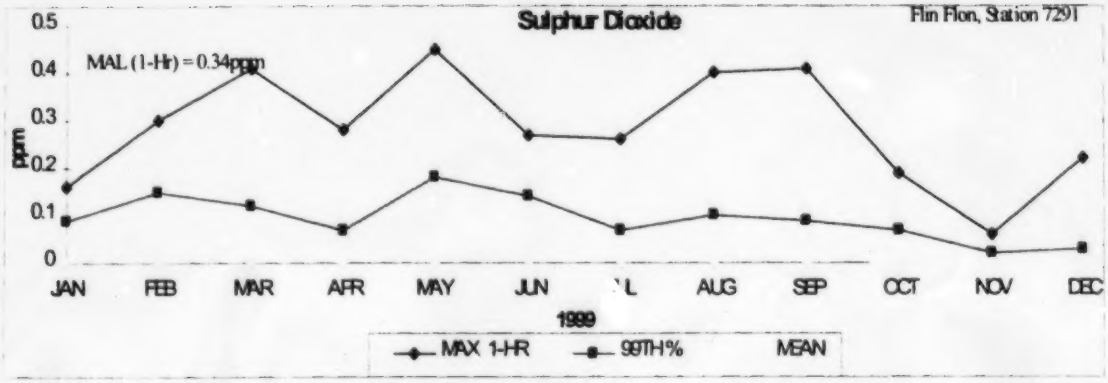

Figure 103. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at the Creighton (Sask.) City Fire Hall, for 1999.

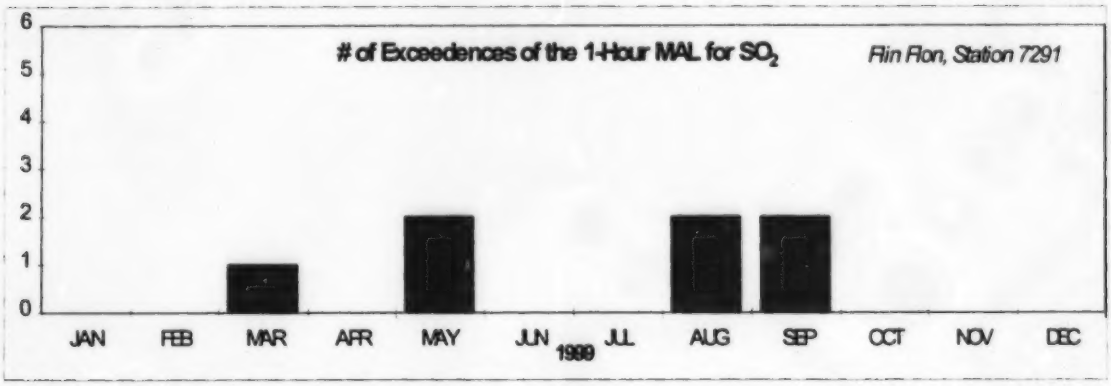

Figure 104. Number of exceedences of the 1-hour MAL for SO_2 for 1999 recorded at the company monitoring site located at the City Fire Hall in Creighton, Sask.

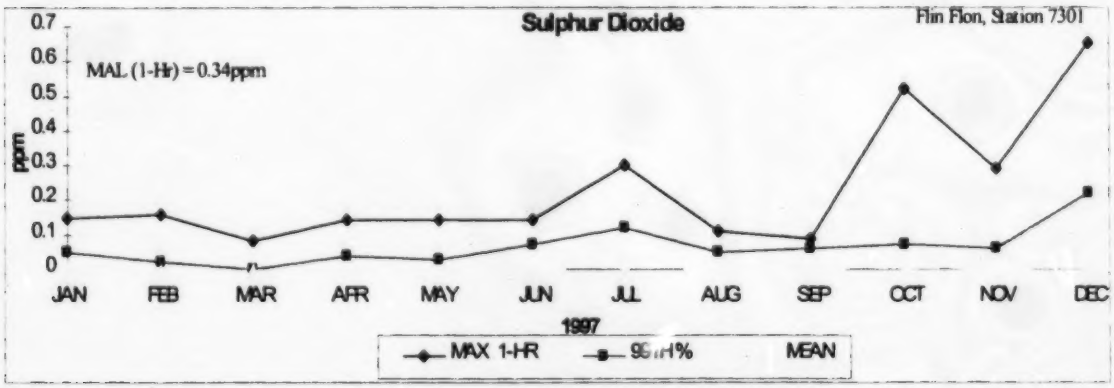

Figure 105. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at Hapnot Collegiate in Flin Flon, for 1997.

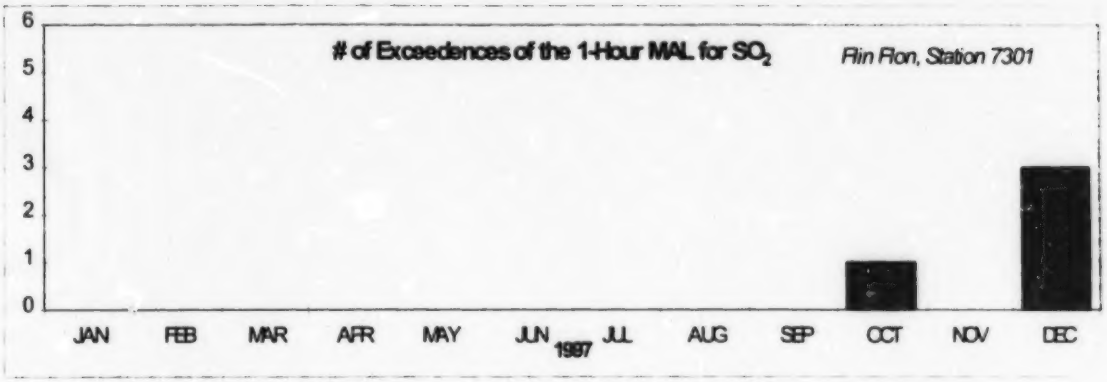

Figure 106. Number of exceedences of the 1-hour MAL for SO_2 for 1997 recorded at the company monitoring site located at Hapnot Collegiate in Flin Flon.

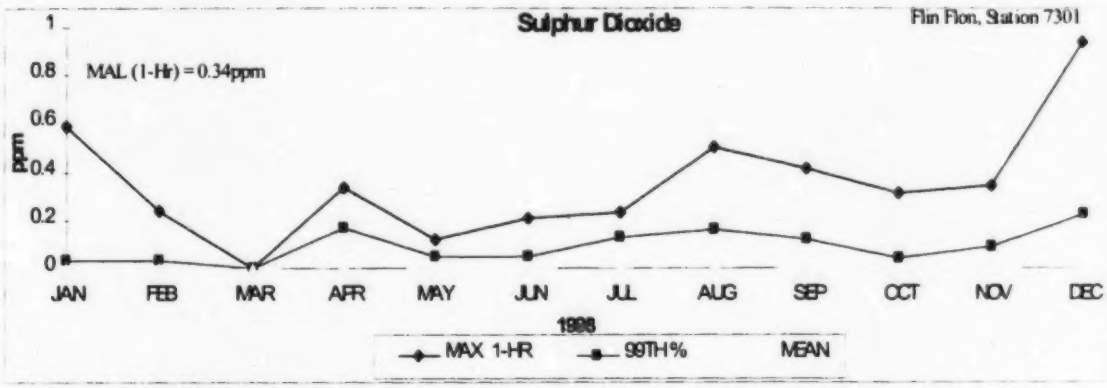

Figure 107. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at Hapnot Collegiate in Flin Flon, for 1998.

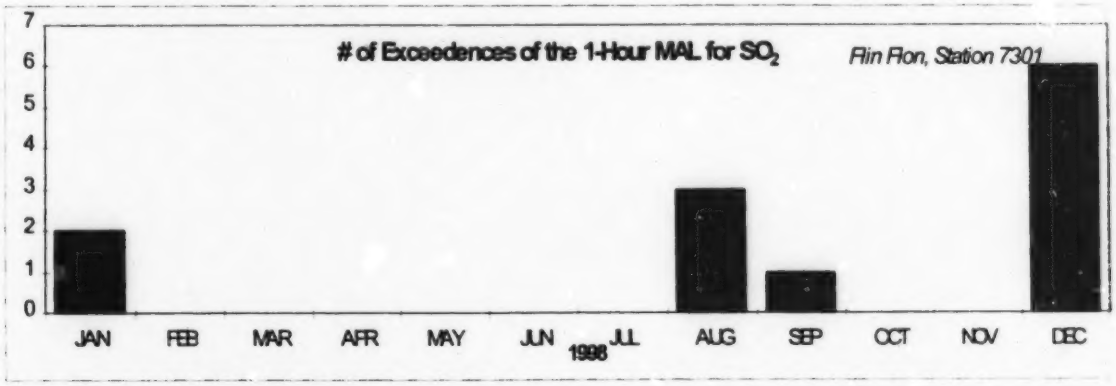

Figure 108. Number of exceedences of the 1-hour MAL for SO_2 for 1998 recorded at the company monitoring site located at Hapnot Collegiate in Flin Flon.

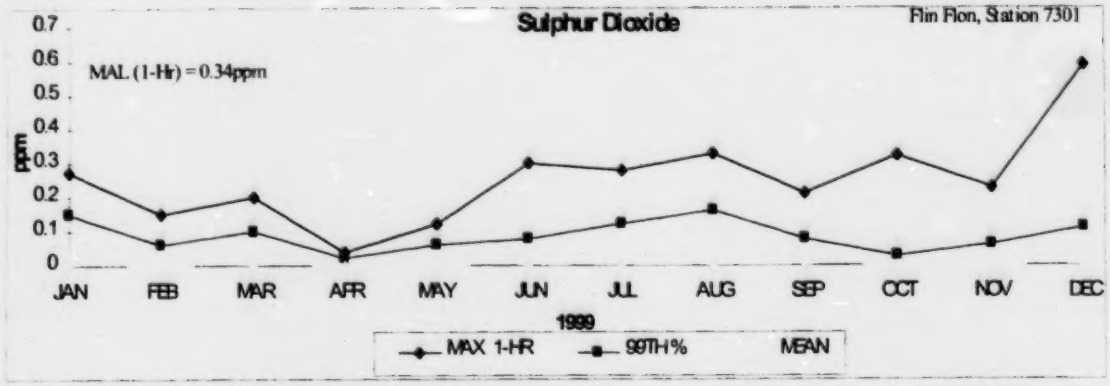

Figure 109. Monthly mean and 1-Hr maximum sulphur dioxide levels calculated and observed for the company monitoring site located at Hapnot Collegiate in Flin Flon, for 1999.

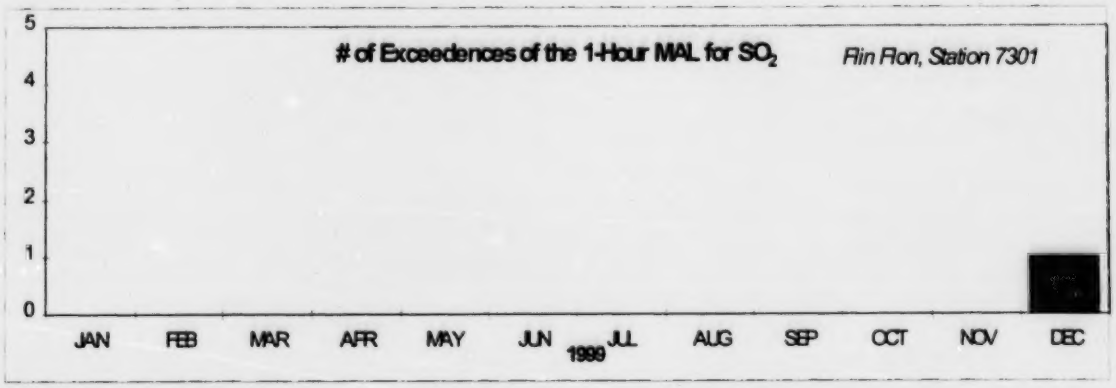

Figure 110. Number of exceedences of the 1-hour MAL for SO_2 for 1999 recorded at the company monitoring site located at Hapnot Collegiate in Flin Flon.

TSP, PM_{10}, Pb, $SO_4^{=}$, NO_3^-, Arsenic (As), Cadmium (Cd), Copper (Cu), and Zinc (Zn)

TSP and PM_{10}, $SO_4^{=}$, NO_3^-, and the heavy metal (Lead (Pb), Arsenic (As), Cadmium (Cd), Copper (Cu), and Zinc (Zn)) content of these particles were also monitored in 1997, 1998 and 1999 by the Province at one location and the company at two other locations within Flin Flon. Annual summaries are presented in Tables 4a, 6a and 8a for the PM_{10} monitoring and in Tables 4c, 6c and 8c for the TSP monitoring. Monthly summaries are shown in Figures 111 to 122 for TSP for the Provincial monitoring site and the two company-operated monitoring sites in Flin Flon. Levels of the sulphate, nitrate and the heavy metals in the PM_{10} samples were generally lower than in the TSP samples.

Three samples in 1997, thirteen samples in each of 1998 and 1999 exceeded the 24-hour MAL for TSP at the provincial monitoring site. One exceedence was observed at one of the company operated monitoring sites in 1997 and 1998, and three exceedences at the other two sites in 1999.

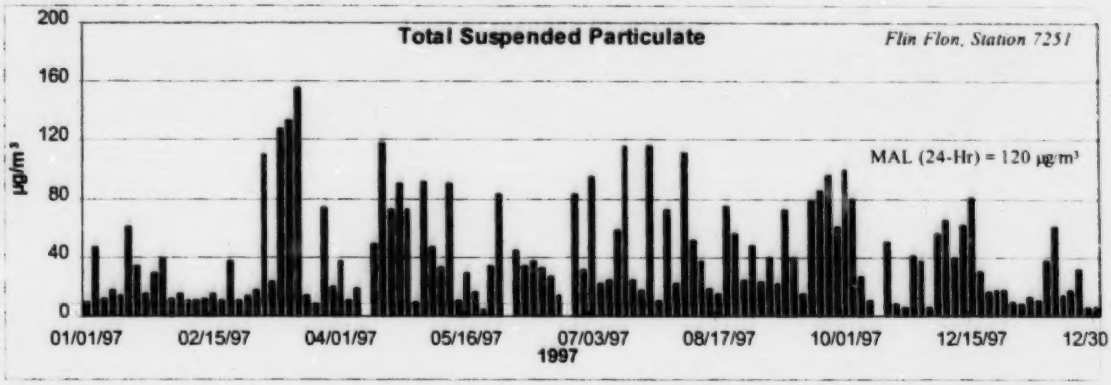

Figure 111. Volume-weighted 24-Hr TSP levels calculated and observed for the Flin Flon downtown monitoring site for 1997.

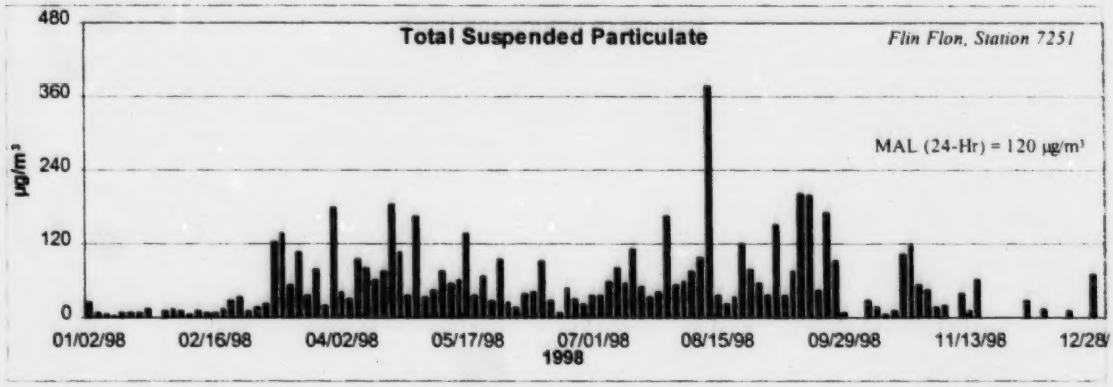

Figure 112. Volume-weighted 24-Hr TSP levels calculated and observed for the Flin Flon downtown monitoring site for 1998.

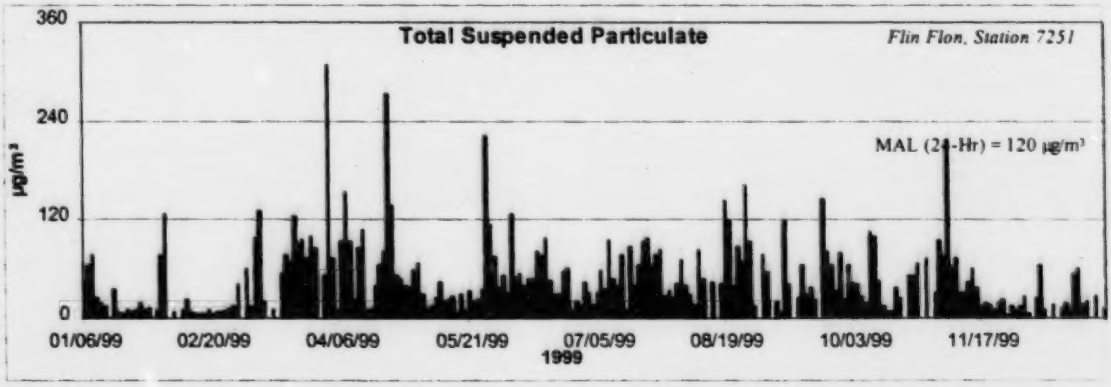

Figure 113. Volume-weighted 24-Hr TSP levels calculated and observed for the Flin Flon downtown monitoring site for 1997.

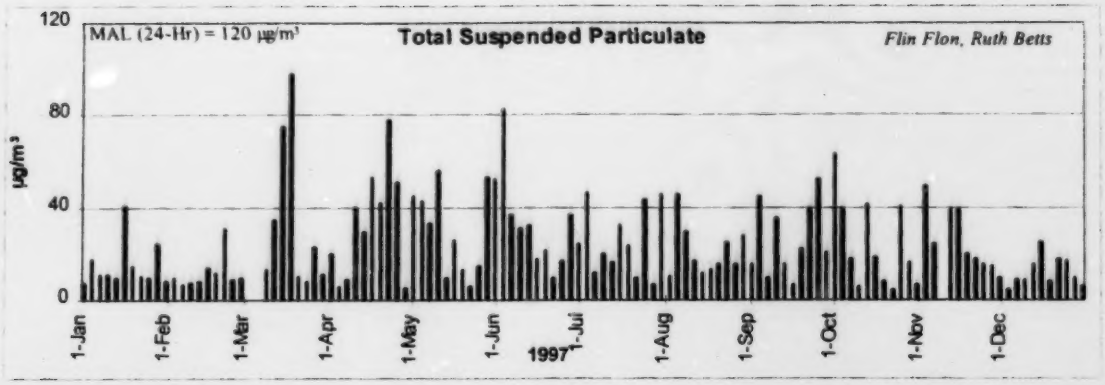

Figure 114. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at Ruth Betts School in Flin Flon for 1997.

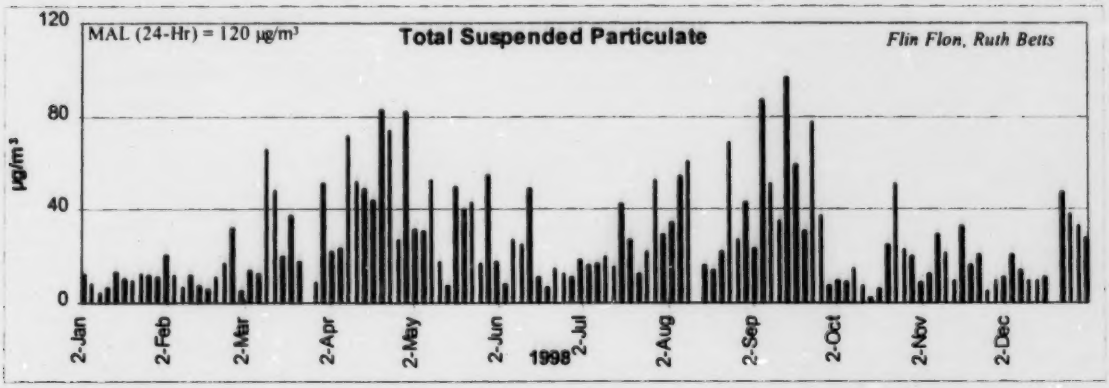

Figure 115. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at Ruth Betts School in Flin Flon for 1998.

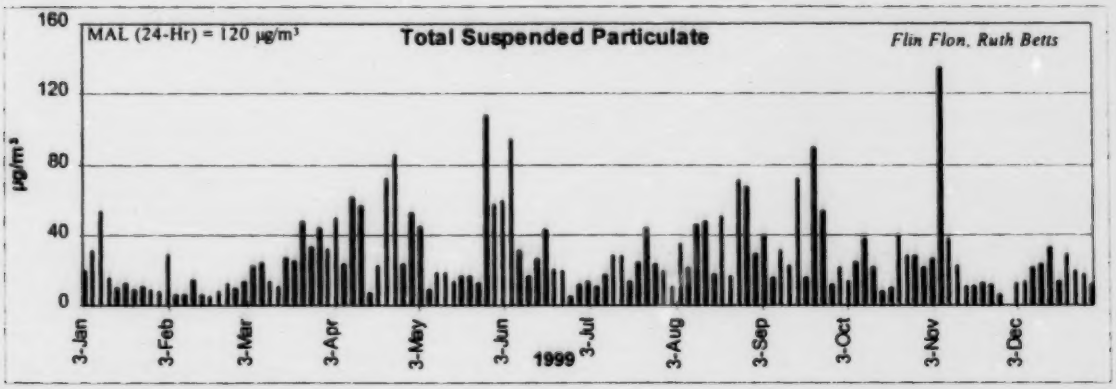

Figure 116. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at Ruth Betts School in Flin Flon for 1999.

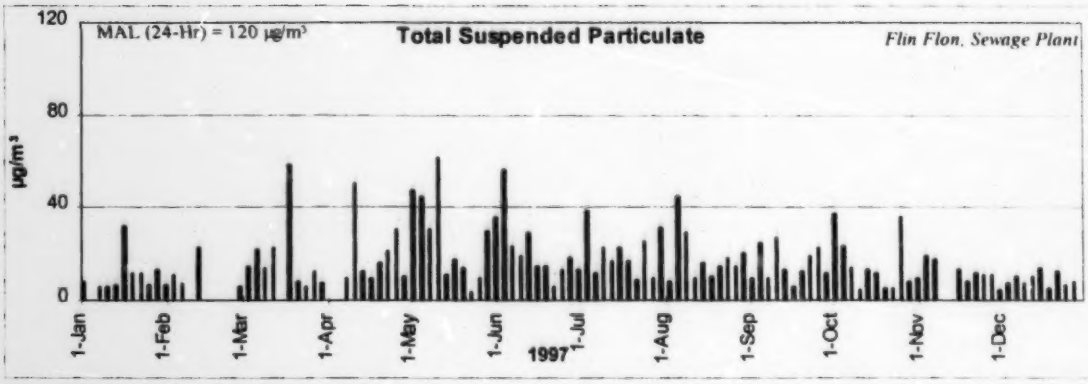

Figure 117. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the Sewage Plant in Flin Flon for 1997.

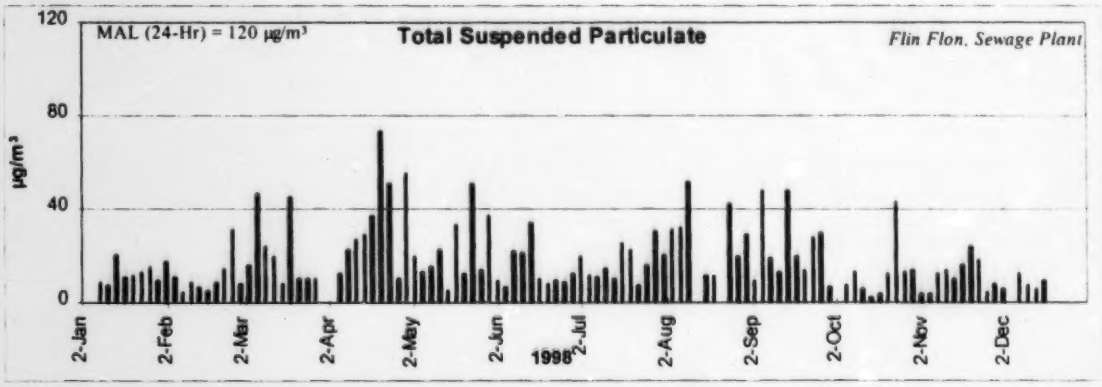

Figure 118. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the Sewage Plant in Flin Flon for 1998.

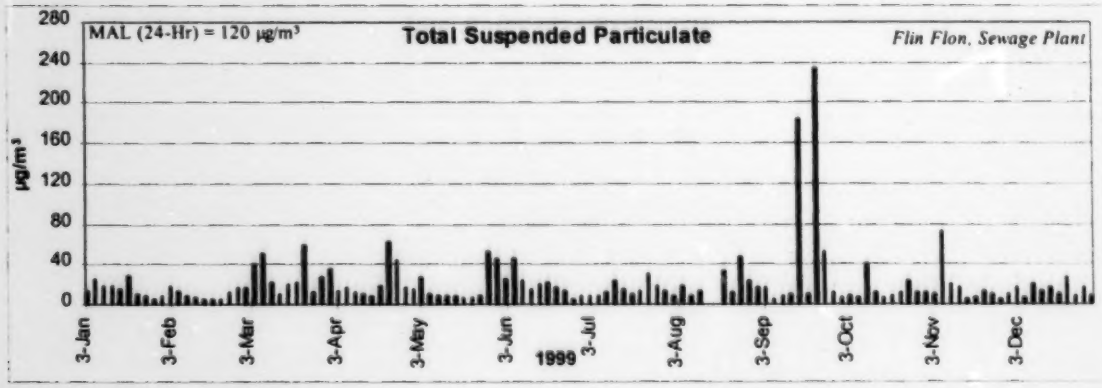

Figure 119. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the Sewage Plant in Flin Flon for 1999.

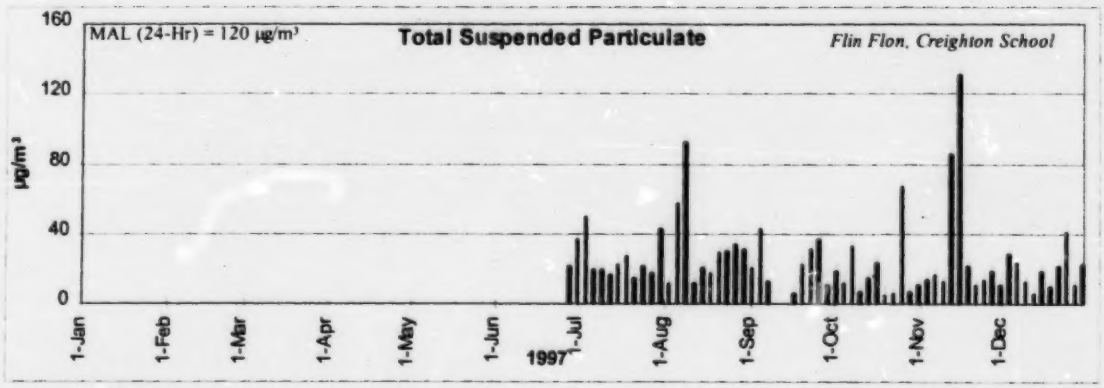

Figure 120. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the School in Creighton, Saskatchewan for 1997.

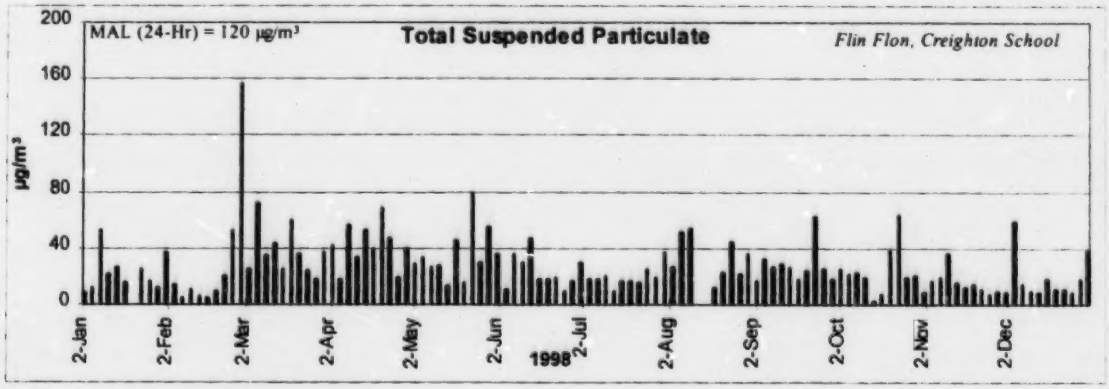

Figure 121. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the School in Creighton, Saskatchewan for 1998.

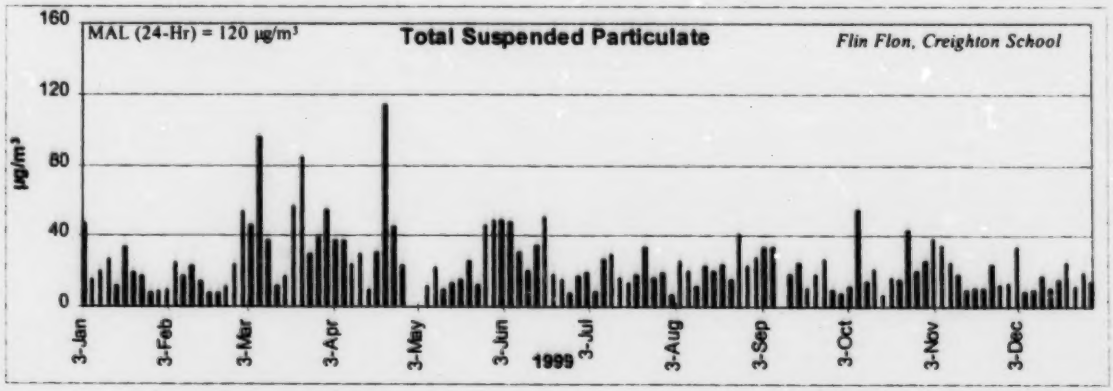

Figure 122. Volume-weighted 24-Hr TSP levels calculated and observed for the company-operated monitoring site located at the School in Creighton, Saskatchewan for 1999.

No samples exceeded the Provincial Guideline of 5.0 $\mu g/m^3$ for Pb in 1997. In 1998 and 1999, 2 and 5 samples respectively exceeded the Provincial guideline for lead. Discussion of the heavy metals As, Cd, Cu, and Zn (Tables 4a and 4c, 6a and 6c, 8a and 8c) will not be included in this report. For the afore-mentioned heavy metals, where there is a listing for exceedences of the 24-hr MAL, the exceedences were based on the Ontario Guidelines for these heavy metals. Other provincial reports specifically relating to heavy metals in Flin Flon are available (Bezak, D. 1991 and Manitoba Environment 1989). Quarterly reports detailing particulate matter (PM_{10}) levels and selected heavy metals levels in dust are produced by Manitoba Conservation and distributed to the media and interested groups and individuals in the Flin Flon area. These reports are also available upon request.

D. THOMPSON AIR QUALITY

SO_2 monitoring in Thompson was conducted only by the local nickel smelting company, which is located south of the town, and the yearly results are shown in Tables 3, 5 and 7. Reported SO_2 emissions from this complex were 208,311 tonnes in 1997, 216,889 tonnes in 1998 and 139,390 tonnes in 1999. There were 5 exceedences of the Provincial 1-hour MAL of 0.34 ppm for SO_2 in 1997, and eight exceedences in each of 1998 and 1999. Yearly trends are shown in Figures 123 and 124.

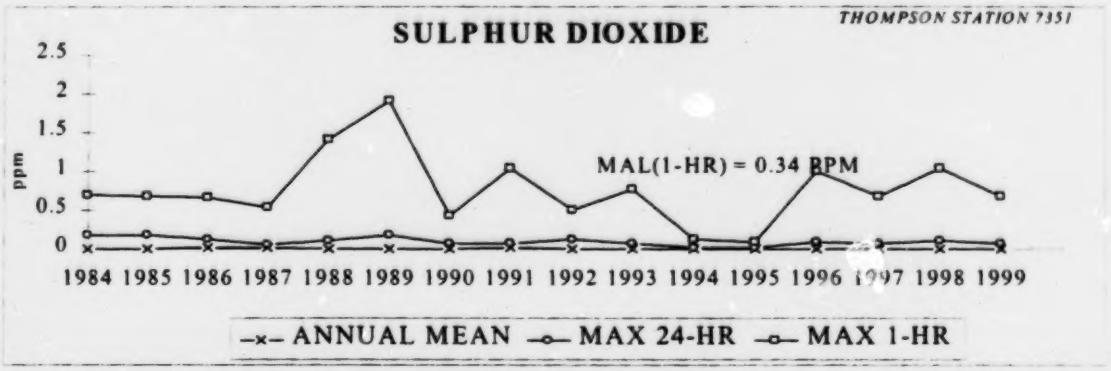

Figure 123. Annual mean, 24-Hr and 1-Hr maximum sulphur dioxide levels calculated and observed for the company operated Thompson monitoring site from 1984 through 1999.

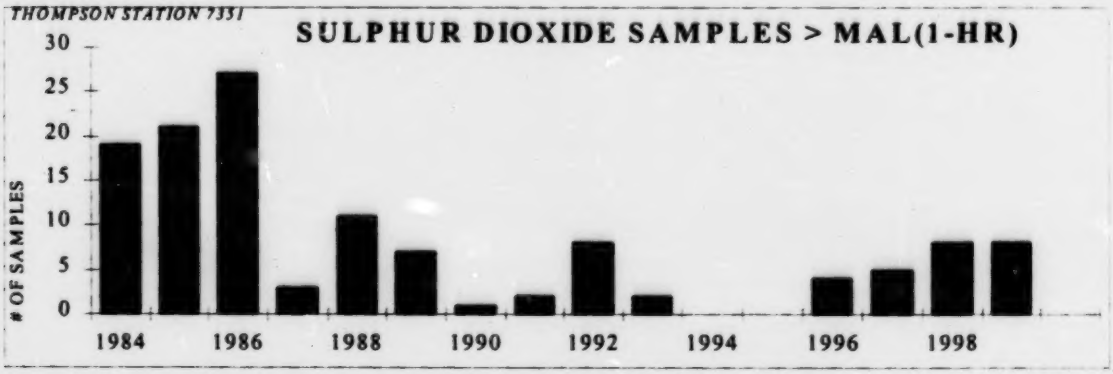

Figure 124. Number of exceedences of the 1-hour MAL for SO_2 annual recorded at the company operated monitoring site in Thompson from 1984 through 1999.

E. TILSTON AIR QUALITY

SO_2 and H_2S monitoring in the Tilston area was conducted by Manitoba Conservation. Results of this monitoring program have been published (Manitoba Conservation 2000a and 2000b) elsewhere and will not be discussed here. These reports are available upon request.

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